SWOV Fact sheet

Effects of police enforcement of safety devices, of moped helmet use, and of red light running

Summary
Not wearing a seat belt or moped helmet, and red light running lead to a higher crash rate or a more serious crash. That is why they have been spearheads of intensified police enforcement in the Netherlands since 1999. The extra seat belt enforcement together with large-scale media campaigns have led to an improvement in seat belt use and a saving of lives in traffic. The extra enforcement of moped helmet use has stopped the declining wearing rate. And finally, the extra camera enforcement has led to a decrease in red light running. The effects of red light cameras on crash rates and the number of casualties have not yet been systematically studied.

Background
Not using seat belts and helmets and red light running are three important offences on which police traffic enforcement focuses. Together with speeding and alcohol offences they are the five spearheads of the regional traffic enforcement plans in the Netherlands. Since 1999 these plans have intensified police traffic enforcement even further (Goldenbeld, 2005). Since 2003 all police forces have a regional traffic enforcement plan.

This fact sheet discusses the effects of police enforcement of protective devices, moped helmet use, and red light running. For each subject we describe the problem, and police enforcement as a possible measure, and we make use of Dutch research in this field as much as possible. This fact sheet is an addition to the fact sheets Police enforcement and driving speed, Driving under the influence of alcohol, and Penalties in traffic which also have police traffic enforcement as a subject. Because this fact sheet discusses three subjects, it is limited to main points and references to relevant studies.

How is police enforcement organized in the Netherlands?
Within the Dutch police force, there are special traffic enforcement teams that concentrate exclusively on traffic; in addition, the regular police also conduct traffic enforcement. For special traffic projects (regional traffic enforcement plans), the police forces receive extra manpower and means from the Traffic Enforcement Team of the National Public Prosecutor's Office (Traffic Enforcement Team, formerly the Public Prosecution Office; BVOM). The Traffic Enforcement Team advises and informs the police and the local Public Prosecution Service (local OM) about traffic enforcement and its results. The local OM steers the police of a district in the carrying out of the traffic enforcement task. The manner in which the special traffic enforcement teams are led might change somewhat when the developments towards a central national police will be realised, but that has not become clear yet.

It seems that the growth of police enforcement in Dutch traffic had reached its peak in 2007 and there has been no further growth since (Weijermars et al., 2010). However, in 2006-2008 the police and the judiciary have made agreements about extra enforcement of red light running by cyclists and moped riders. This has been set down in the regional covenants on spearhead programmes in which agreements between police and the judiciary are set down and signed by heads of police forces, the head of public prosecution, and the Traffic Enforcement Team for the Board of Procurators-General.

How does police enforcement work?
Police enforcement works on the probability of being caught. The roadside checks represent the objective probability, also known as the enforcement pressure. Using the enforcement pressure, what they read in the newspapers, and what they hear from friends and acquaintances, road users estimate the probability of themselves being caught committing an offence; this is known as the subjective probability. This estimated probability of being caught acts as a stimulus to avoid committing offences. Psychologists call this extrinsic motivation because behaviour is steered by external stimuli such as rewards or, in this case, punishment.

In general, the preventive effects of police enforcement are stronger with increasing subjective probability and certainty of punishment, and with punishment quickly following the offence (Goldenbeld, 2005). Each of these elements is a link in the chain of enforcement and - to continue this metaphor - the chain is no stronger than its weakest link. If for example, the subjective probability is small, the penalty, certainty of being punished, and time between punishment and offence will not make much difference in the preventive effect. The subjective probability can be increased by 1) publicity about the enforcement activities, 2) the checks being highly visible, 3) unpredictable sequence and locations of random checks, 4) select checks at times and places with a high probability of offenders being actually caught, and 5) making police checks difficult to avoid.

Every country has a certain basic level of regular police traffic enforcement, often expressed in the annual hours of traffic enforcement or an annual number of traffic police checks. A stable enforcement level is, in the long run, insufficient to further reduce the number of offences. Bjørnskau & Elvik (1992) point to the fact that the regular enforcement level must be increased with a factor of two, three, or even four in order to have effect on behaviour and thus road safety. Based on eleven international studies of speeding enforcement, Elvik (2001) assessed that an ever higher level of speeding enforcement leads to ever less extra safety benefit, expressed in prevented injury crashes. The 'law of diminishing returns' seems to apply here. Based on various speeding enforcement studies, Elvik (2011) has recently estimated the relation between intensifying the level of enforcement (expressed in the number of hours, sometimes also of checked vehicles or number of fines) and change in road safety. According to this study, doubling the speeding enforcement leads to a 20% decrease in injury crashes at these locations, roads or road sections where the doubling has taken place. Further intensification leads to a decrease of unsafety, but the returns in safety do diminish after further intensification.

Why is it obligatory to use safety devices?

Research has shown that wearing a seat belt reduces the fatality rate by 40% for the front seats of a car and by 30% for the rear seats. The use of safety devices for children halves the fatality rate. Seat belts are more effective in front seats than in rear seats because the rear seats are already a safer environment than the front seats. This and other information can be found in the fact sheet Seat belts and child restraint seats.

The importance of seat belts has been known for a long time. That is why on 1 June 1975 the seat belt was made obligatory in the Netherlands for car occupants in the front seats. On 1 January 1990 it was made compulsory to have seat belts installed on all seats of new cars i.e. including rear seats. Since 1 April 1992 all car occupants, including children, are legally obliged to indeed wear these seat belts. From 1 March 2006 new rules apply to transporting children safely. Children shorter than 1.35 metres must sit in an approved child seat, and children and adolescents taller than 1.35 metres must wear a seat belt, if necessary in combination with a booster seat.

What is the effect of police enforcement on seat belt wearing?

During the 1980s, several provinces in the Netherlands conducted seat belt campaigns consisting of a combination of police enforcement and various types of publicity (Goldenbeld, 1993). These campaigns had very positive results: they often resulted in an increase in seat belt use of 20 percentage points or more. This increased seat belt use often continued for at least 3-6 months after the end of the campaign. More recently, using 2002 data, Mathijssen & De Craen (2004) determined that the front seat seat belt use in cars was 8-14 percentage points higher in police regions with a regional traffic enforcement plan than in regions without such a plan. In this study seat belt use was compared in police regions within the Province of North-Holland. Two regions which already had operational regional plans for some years had a seat belt use of 95% and 98%. Three police regions without operational regional plans had a seat belt use of 88%, 84%, and 87%. This difference was very probably a result of the increased enforcement of seat belt use in the areas with a regional plan.

During the last decades an increasing number of drivers have been wearing seat belts in the Netherlands (see *Figure 1*). There are strong indications that since 1999 intensified seat belt enforcement, often combined with national or regional publicity campaigns, has increased driver seat belt use. On rural roads, seat belt wearing rates among drivers increased from 80% in 1998 to 97% in 2010; on urban roads the wearing rates increased from 67% to 96%. The difference between urban and rural roads has disappeared. During the last few years seat belt wearing in the rear seats also increased considerably: from 40% on urban roads in 1998 to 79% in 2010, and on rural roads from 43% to 85%.

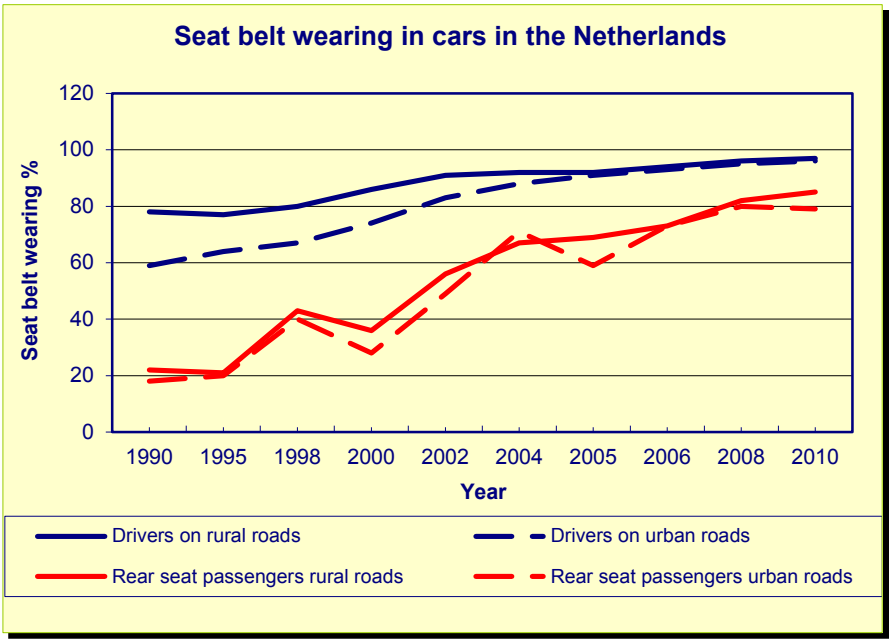

Figure 1. *Sources: Mulder, 1998; DVS, 2010.*

Between 2008 and 2010, the number of children that travelled fully conform regulations decreased by 20% (DVS, 2010). This is caused by the fact that more children travel in a seat with seat belt rather than in a child restraint seat or on a booster seat with seat belt; this percentage increased by 19% from 6% in 2008 to 25% in 2010. The percentage of children that travelled without a seat belt or child restraint seat remained the same between 2008 and 2010 (6%). Having a child travel on a seat with a seat belt is not conform legislation. The seat belt offers some level of protection, but considerably less than a seat belt combined with a child restraint seat or a booster seat. The booster seat ensures that the hip part of the seat belt indeed covers the hip and not the stomach, so that the risk of severe internal injury in a crash is decreased.

Does police enforcement of seat belt wearing improve road safety?

Mathijssen & De Craen (2004) have estimated the effect of the intensified police enforcement of seat belt wearing and how many lives this had possibly saved. They estimate that during the 1995-2002 period the intensified enforcement resulted in an increase in driver and passenger seat belt use by 23% in those police regions where intensified police enforcement had been regulated in a regional plan. According to their estimate, between 1994-1995 and 2000-2001 this resulted in an extra 4 to 5% decrease in the number of casualties in regions with a regional plan than in regions without one. For the Netherlands as a whole they estimated that the increased seat belt use resulting from the intensified police enforcement, in combination with campaigns, had saved 3% of all road deaths or approximately 30 deaths a year between 1994/95 and 2000/01 (Mathijssen & De Craen, 2004; p. 55).

In 2003-2007 the intensified police enforcement of seat belt wearing was supported by mass media campaigns about the benefit and necessity of the seat belt. These campaigns were part of a broader long-term road safety campaign under the central motto ‘Getting home safely’. In 2004 the seat belt campaign was extended to children as a target group with the Armadillo campaign. The Centre Transport and Navigation (DVS, 2008) has estimated the annual effect of the combined police enforcement and campaigns to be eleven road deaths and eighty in-patients for all car occupants in 2003-2007 when compared with 2002. This saving of 55 road deaths over the period 2003-2007 was a saving of 1%, which, relatively speaking, was less than the 3% fewer road deaths in 1994-2001. This is not so surprising because the law of diminishing returns applies here: the higher the national level of seat belt use, the more difficult it is to achieve even greater behaviour change and safety benefit (see also Elvik, 2001).

Why is moped helmet wearing obligatory?

The moped helmet has an important protective working: wearing a helmet correctly reduces motorcyclists' and moped riders' risk of dying in a crash by half (Noordzij et al., 2001). In the

Netherlands, it has been mandatory for moped riders to wear an approved helmet since 1975. The Dutch Traffic Regulations (RVV 1990) state that this helmet must fit well and must be worn in the proper manner.

Which effects does police enforcement have on wearing a moped helmet?
The use of moped helmets declined during the 1990s. The wearing rate was 98.5% in 1996 but this went down to 92.5% in 1999 (Goldenbeld & Batstra, 2000). This declining rate together with the high crash involvement of young moped riders were reasons to make moped helmets a spearhead in the intensified police enforcement projects.

Every year, the Traffic Enforcement Team of the National Public Prosecutor's Office carries out measurements to monitor helmet use, and also proper helmet use. In the annual measurement of 2008, it was found that 96% of moped riders wore helmets, an improvement of around four percent compared to the 1999 measurement. Furthermore, it was found that 90% of moped riders had fastened the chin strap, and that 87% of moped riders wore the helmet on the head correctly. Since 2008, no new measurements of helmet use have taken place.

Does police enforcement of moped helmet use improve road safety?
We may assume that the police enforcement of helmet use most certainly has made a positive contribution to moped riders' safety, but the effect has not yet been quantified. There are several indications that police enforcement has stopped the decline in helmet use. A quantitative estimate requires an assumption about how the use of moped helmets would have declined without extra enforcement and such an assumption is partly speculative.

Why is red light running a problem?
Red light running is a worldwide road safety problem. For example, it leads to an estimated 850 road deaths per year in the United States, which is about 2% of all road deaths (IIHS, 2000). In 2009, red light running was the main crash cause in the Netherlands in 5.3% of the fatal crashes (32 out of 597) and also in 3.7% of the serious in-patient crashes (155 out of 4.137; sources: Dutch Ministry of Infrastructure and the Environment and Dutch Hospital Data). *Table 1* shows the development in the number of road deaths and serious injuries as a result of red light running in the years 2007-2009.

	2007	2008	2009
Road deaths	26	26	33
Serious injuries (MAIS 2)	225	206	158

Table 1. *Development in the registered road deaths and serious injuries as a result of red light running (first cause) in the years 2007-2009. Sources: Dutch Ministry of Infrastructure and the Environment and DHD).*

Red light running therefore often has the most serious consequence: a crash with fatal injury. Comparatively, the problem is greater in the Netherlands than in the United States. This is probably due to the fact that there are more vulnerable road users in the Netherlands: pedestrians, cyclists, moped riders and motorcyclists.

How is police enforcement of red light running organized?
If at an intersection there is a lot of red light running this may be due to the view there or the traffic light phasing. In such cases police enforcement is not the best solution; a solution can rather be found in the Handbook traffic light provisions (Handboek verkeerslichtenregelingen; CROW, 2006). Raised intersections, for example, can reduce the speed of approaching and red light running at rural intersections regulated by traffic lights, and can thus improve road safety (Fortuijn et al., 2005).

On the basis of an accident analysis, the regional steering committee (including representatives of the Traffic Enforcement Team, road authority, police) determines the most appropriate intersections for installing the red light cameras which are made available by the Traffic Enforcement Team for the intensified police enforcement. In the Netherlands in August 2011, slightly more than 600 red light and speed cameras were managed by the special enforcement teams. In addition, several hundreds of

cameras were managed by the regular police. A cautious estimate is that each year there are at least 1000 intersections in the Netherlands at which red light cameras are working for a short or longer time.

The red light cameras in the Netherlands register offences in the various lanes (straight on, left turn, right turn) from only *one* direction and usually also register speeding offences. Some of the cameras are circulated among various intersections. During the 2006-2012 period the current red light cameras and speed cameras are being replaced by digital cameras that automatically send information about offences to a central computer (BVOM, 2006). As digital cameras do not need a film changed, the police do no longer need to remove the cameras from their boxes and it is no longer practical to circulate them among various intersections.

In the regional traffic enforcement plans 2000-2004 of the police and the former BVOM, the red light running spearhead mainly focused on motorists. The more recent plans, which started in 2005, also cover intensified enforcement of red light running by cyclists and moped riders. This police check is usually carried out by two policemen, of which one visually detects the offence and the second halts the offending cyclist or moped rider. In 2010, more than 300,000 motorists were fined for red light running, which amounts to 3% of all fines (CJIB, 2008).

In June 2011, the Traffic Enforcement Team set up directives for the placement and use of speed and red light cameras (LP Team Verkeer, 2011). These directives state that newly placed red light and speed cameras must always be conspicuous through police striping on the cases and that a red light camera always enforces speed as well.

Which effects does police enforcement have on red light running?
During the 1994-1997 period Oei et al. (1997) studied the effects of red light cameras on offences at four very different locations in Amsterdam: A) a road going straight on, B) a T-junction, C) an intersection, and D) a motorway entry over the period 1994-1997. The offence rate declined at all four locations: at A from 3% to 1%, at B from 2.5% to 1.3%, at C from 8.2 to 3.4%, and at D from 1.6% to 0.5%.

According to the former BVOM, in 2003 the number of red light runners had declined to about 1% at intersections where they had installed red light cameras, but no offence rate was reported for the period before the cameras were installed (BVOM, 2003). It is difficult to establish the offence rate before the camera enforcement objectively, because at a number of intersections the cameras were installed at the same time as the offence rate measuring equipment. However, Oei et al. (1997) reported offence rates varying between 1.6% and 8.2%, from which we could derive that the average initial offence rate amounted to at least several percentage points.

Maccubin et al. (2001) made an inventory of the effects of red light cameras on offence rates in 22 enforcement projects, mainly in America. They found that the offence rates declined by 20% to 87%. In about half of the projects the reductions were between 40% and 62%. However, Maccubin et al. point out that for a number of these estimates no good before-rate had been measured.

Does police enforcement of red light running promote road safety?
Retting et al. (2003) concluded from a meta-analysis of eight international studies that red light cameras lead to 25-30% fewer injury crashes. Yet, even when a net positive effect on the total number of injury crashes was observed, Retting et al. (2003) often found an increase in the number of rear-end crashes. This is probably because some motorists brake suddenly to avoid a red light running fine. This side effect can be avoided by placing the cameras so that they are clearly visible, and by using warning signs. In a later review Aeron-Thomas & Hess (2005) conclude that there is consistent and conclusive evidence that red light cameras reduce the number of injury crashes. One of the most thorough studies in that survey gives an estimate of a 29% reduction due to red light cameras – a percentage which agrees with the earlier estimate by Retting et al.

A recent meta-analysis based on a selection of the best methodological studies concluded that although red light cameras do indeed decrease the number of side crashes, at the same time they increase the number of rear-end crashes as well as the total number of crashes (Erke, 2008). The meta-analysis, however, does not subdivide into injury severity. Therefore, the effect of red light cameras on the injury severity rate is not altogether clear. The meta-analysis has also been criticized because bad-quality studies would have had too great an importance in it (Lund et al., 2009). The

most recent large-scale study into the effects of red light cameras in large American cities clearly shows positive effects: a 24% reduction in the number of crashes caused by red light running, and a 17% reduction of fatal crashes at intersections regulated though red light cameras (Hu et al., 2011, not yet available).

Overall, the results of the study are positive. However, the safety effects of red light cameras rather vary between studies, and, within the same study, also between intersection types. As yet, research has not shown any possible explanations for these differences. Variables that may be of importance are: the phasing of the traffic lights, the offence rate before the cameras were placed, early warning signs about the cameras, and the cameras' visibility. An overall positive safety effect of red light cameras is to be expected mainly at intersections with relatively many serious side crashes which are related to red light running and relatively few rear-end crashes (Shin & Washington, 2007). Langland-Orban et al. (2011) specifically point out that red light cameras are not a solution to the problem of unintended red light running when people unintentionally go through a red light. An analysis of the problem, which shows the cause of red light running at an intersection, should be carried out before deploying a red light camera.

The combined effects of red light cameras and other red light enforcement measures to realize safety on intersections in the Netherlands have not yet been investigated. An assessment study in the Dutch city of Amersfoort showed positive safety effects that were comparable to those in the reviews by Retting et al. (2003) and Aeron-Thomas-Hess (2005), viz. a 20% reduction of the number of injury crashes (Dobbenberg, 2006; Via Verkeersadvies, 2005). This study found no increase in the number of rear-end crashes.

Conclusion

Police traffic enforcement aims at improving traffic behaviour by warning road users that they can be caught committing a traffic offence, i.e. influencing the subjective probability of being caught. This is a necessary supplement to infrastructural and educational road safety measures. Not wearing a seat belt or moped helmet and red light running at intersections are offences that are accompanied by increased crash severity or crash rate. For this reason they have been designated as spearheads of intensified police enforcement by the Traffic Enforcement Team of the National Public Prosecutor's Offic and the police.

The more intensive police enforcement of seat belt wearing has improved seat belt use. This is partly because the extra police enforcement was supported by a mass media national campaign and by congruous regional media campaigns.
Together with intensified enforcement of helmet use by moped riders a gradual improvement in the helmet use has taken place in the 1999-2008 period. From 1 January 2007, mopeds and light mopeds must have a number plate. This makes it much easier for the police to identify a moving moped and thus optimize enforcement.
A positive safety effect of red light cameras can be expected especially at intersections where relatively many side crashes related to deliberate red light running take place, and where relatively few rear-end crashes occur. In the Netherlands, the safety effects of red lights have not yet been studied systematically, but a decrease in the number of red light offences because of enforcement has been found.

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