SWOV Fact sheet

Training hazard perception

Summary
Hazard perception is an essential skill in the driving task, but it is still badly developed among novice drivers. Hazard perception consists of more than perceiving hazards. It also concerns appraising the seriousness of the hazards, and knowing how to act to avert them. There are indications that drivers learn to perceive hazards in practice as a result of occasionally finding themselves in hazardous situations that frighten them. Various training programmes have shown to be effective. Some of these training programmes make use of films and photos; others also make use of computers. A basic principle of the training programmes is that students are asked to predict events. Hazard perception training with a driving simulator is still in its infancy, but looks promising. Hazard perception can also be learned during regular driving lessons. Merely including a hazard perception test in the driving test, without setting requirements for hazard perception training in the driving course, may result in drivers only learning tricks. In this case, the effect on learning to perceive hazards may be limited.

Background and contents
Hazard perception is perceiving and recognizing visible and hidden potential hazards in time, but also appraising the seriousness of the hazards and knowing how to act to avert the hazards (see SWOV fact sheet *Hazard perception in traffic*). Novice drivers still have difficulties with this skill.
This fact sheet discusses the ways hazard perception may be learned through training. Training is actually intended to speed up the process of acquiring the skill to perceive hazard perception in practice. The way in which perceiving hazards is learned while gaining driving experience is discussed first. Next, a number of training programmes that have shown to be effective are discussed. They include courses using films and photos, as well as computer training and simulator training. The possibilities to train hazard perception during the regular driving lessons are also discussed. Finally, it is considered what the effect may be of including a hazard perception test in the driving test.

How do drivers learn to perceive hazards in practice?
Hazard perception is shown to improve through acquiring more driving experience, which results in a decreasing crash rate (see SWOV fact sheet *Hazard perception in traffic*). The question is how novice drivers learn to perceive hazards early enough in the everyday traffic situation. This knowledge is important for developing effective training methods for hazard perception.

There are indications that drivers learn to perceive hazards mainly as a result of previous situations in which emotions were experienced. Groeger (2000) showed that drivers also 'feel' hazardous situations when they perceive them. When drivers indicated that they considered a driving task as hazardous while driving, they also turned out to have a faster heartbeat and heightened skin response, and also had increased eye movement compared with ordinary situations. Other studies also indicate a link with emotions (Groeger & Chapman, 1996; Chapman & Groeger, 2004). A week after they had watched a film shot from the driver perspective, drivers could still remember the hazardous traffic situations, but they did not remember the non-hazardous ones. Moreover, they remembered in particular details of the hazardous situations that were important for traffic safety (such as the position and the speed of the other car, but not its colour). Drivers seem to perceive hazards because they previously experienced similar situations that led to near misses, and during which they also felt a certain degree of emotion.

One theory that explains how people learn in situations in which emotions are experienced is the theory of Damasio (1994). According to his hypothesis, emotion-related signals of the autonomous nerve system (perspiring, increased heartbeat and suchlike) can unconsciously influence complex decision-taking processes. Neurobiologists have also discovered how emotions influence the connection between various sensory perceptions and the consolidation of memories (McGaugh, 2000). In short, there are neurological indications that emotions experienced in hazardous situations in the past, play an important role in recognizing similar situations and in taking decisions to act. This

means that in traffic situations drivers mainly learn to perceive hazards as a result of having experienced previous situations in which they had been frightened into realizing that they had had a narrow escape.

Neurological theories are not the only ones that explain how people learn to perceive hazards in practice. The schemata theory is a theory in which emotions do not play a role (see Piaget, 1967, among others). Schemata are mental structures representing specific aspects of our reality. For instance, one schema is driving on a motorway. Based on this schema, drivers expect certain aspects (for instance, other cars that drive into the same direction with more or less the same (high) speed), and do not expect other aspects (oncoming vehicles, pedestrians, cyclists). While driving on the motorway, the 'motorway schema' is active in our brain in the background. Due to experiencing traffic situations that do not correspond with the original simple schema, this schema is developed and modified, if necessary. As a result, the schemata become increasingly complex, so that the expectations of what may happen continuously increase. The majority of hazard perception trainings that have been developed so far take the schemata theory as their starting-point, either explicitly or implicitly.

Can hazard perception be trained in courses using films and photos?
Training is intended to speed up the process by which hazard perception is learned in practice. Two important criteria to assess the quality of training are *transfer* and *retention*. Transfer is successful when people know how to apply in practice what they have learned during the course. Retention is successful when people retain their knowledge. Various studies have shown that it is possible to train hazard perception without participating in traffic. Below follow descriptions of three training methods that have shown to be effective:

1. During the hazard perception training developed in Great Britain by McKenna & Crick (1997), novice drivers receive approximately four hours of instruction in hazard perception in the course of three weeks. In class the students are shown video images taken from the driver perspective. At a particular moment the images are frozen and the trainer asks the students what will happen next and what they would do if they were the driver (brake, for example). The trainer provides the students with feedback on their answers and gives instructions. After having completed their training, the students scored significantly better on a hazard perception test than before the training. The novice drivers scored practically as high as did drivers with ten years of experience.

2. In the United States the so-called Risk Awareness and Perception Training (RAPT) was developed (Fisher et al., 2006). Students are first presented with a pre-test: on a PC they are shown a sequence of photos of a developing traffic situation taken from the driver perspective. The students have to click with the mouse on spots in these images that they particularly want to keep an eye on with respect to safety. Different from McKenna & Crick's hazard perception test, Fisher et al. mainly focus on hidden hazards (see SWOV fact sheet *Hazard perception in traffic*). The feedback and the actual training are mainly presented by means of schematic depictions of traffic situations from above. These schematic depictions are intended to improve transfer. The final part of the study consists of a post-test, which is similar to the pre-test. Participants in this training turned out not only to score significantly better in the post-test than they did in the pre-test, but their viewing technique while really driving in the road had also considerably improved. This could be measured because, while driving, test drivers were fitted with an eye tracker, a devise for measuring eye movements.

3. Chapman et al. (2002) introduced training to improve the viewing technique of novice drivers. During this training, students watch film images taken from the driver perspective. Circles appear on these images and a voice-over explains why it is important to keep an eye on these encircled areas. Next, the students have to comment on the images they are presented with. First, the images are shown at half speed; later, the images are projected at their regular speed. The entire training lasted just less than an hour. Prior to the training the students drove a car while wearing an eye-tracking device that registered their eye movements. Immediately after completing the training, they again drove a car while being monitored by an eye tracker, and six months later this was repeated again. As a result of the training, students turned out to spot potential hazards more often and they also retained this skill.

Can hazard perception be trained by self-tuition on a computer?
Training programmes have also been developed for CD or DVD, so that novice drivers can practise on their computers at home. In the United States in the late 1990s, the AAA Foundation for Traffic Safety introduced the 'Driver-Zed' programme. In Australia, the Monash University Crash Research Centre (MUARC) developed the 'Drive Smart' application. Drive Smart was introduced in 2000.

Driver-Zed uses a combination of the didactic methods that have been discussed in the previous section. Video fragments freeze and the students have to predict what will happen next. Students have to click on hazardous spots on the still video fragments and they are shown video fragments that they have to freeze by pressing on a button when they consider the situation becoming hazardous. Special modules have been developed for roads in urban areas, for roads outside urban areas and for motorways. On the behavioural level, Driver-Zed has been evaluated in a driving simulator (Fisher et al., 2002). Two weeks after having completed the Driver-Zed training, novice drivers drove significantly more carefully in a driving simulator and they detected looming hazards more quickly than untrained novice drivers. The driving simulator scenarios differed from the ones used in Driver-Zed. Therefore researchers conclude that transfer had taken place and that a kind of general risk awareness had developed.

Drive Smart operates in more or less the same way as Driver-Zed. In addition to hazard perception, Drive Smart also explicitly pays attention to establishing priorities and calibration (see SWOV fact sheet *State awareness, risk awareness and calibration*). In contrast with Driver-Zed, Drive Smart is not voluntary. The Australian state of Victoria has a graduated driving licence system which includes a hazard perception test. Drive Smart is intended as training for this hazard perception test. The effect of Drive Smart has been measured with a driving simulator (Regan et al., 2000). In the case of looming hazards, the Drive Smart group did better than the control group (for example, they braked sooner), even though the differences were not very large. Moreover, retention was also perceived.

Can hazard perception be trained in a driving simulator?
Students can be confronted with hazards in driving simulators without suffering serious consequences. For this reason, a driving simulator is in principle an ideal educational tool for a training that is based on the theory that people learn most successfully in situations where emotions are experienced (see section How do drivers learn to perceive hazards in practice?' in this fact sheet). Nevertheless, no more than one example is known of hazard perception training that explicitly makes use of this benefit of simulators. Ivancic & Hesketh (2000) developed and evaluated simulator training with students driving in a scenario with various hazards manifesting themselves. Another group drove in the same scenario without hazards becoming manifest, although hazards were hinted at. After having completed the training, both groups drove in the simulator. The same types of hazard occurred during this drive, but in a different setting. During this drive the hazards did not manifest themselves. It turned out that the group who had been confronted with hazards during training drove significantly more slowly in situations where hidden hazards could manifest themselves, compared to the group who had been trained, but who had not been confronted with hazards in the course of the training. It also turned out that the group that was confronted with hazards had not become more confident in their own ability as a result of the training. If they had gained greater confidence, this could have resulted in behavioural adaptation, so that they would have dared to take greater risks in practice as a result of having had training (see SWOV fact sheet *Post-license training for novice drivers*).

In Sweden, simulator training has been developed for basic driver training including hazard perception. In the course of this training, students drive in scenarios containing hazards. For instance, a car is standing still in a blind bend in the road. If students were to round the bend too fast they would drive into this stationary car. If students drive into the car in the bend during training, they have to drive the same scenario again. Falkmer & Gregersen (2003) studied whether this training improves hazard perception. They therefore had subjects drive in scenarios in an advanced research simulator that were similar to the training scenarios, although the setting was different. It was then measured, for instance, at what point in the scenario students adjusted their speed. After completion of the training, novice drivers were found to anticipate better in certain test situations, but failed to do so in the majority of situations. A possible explanation of this rather poor effect is that the training included too much and that it lacked a clear-cut didactic method. Hazard perception was no more than a small part of the simulator training and no clear feedback was given on hazard perception in the scenarios.

Allen at al. (2008) developed a simulator training in the United States that includes hazard perception (see SWOV fact sheet *Simulators in driver training*). How hazard perception is trained in the simulator does not become clear. Students who had trained in a fairly advanced simulator showed a lower crash rate during the first few years after having passed their driving test, compared to students who had trained in a very simple simulator (one monitor, one steering wheel for computer games and the brake and accelerator pedals) or students that had not had simulator training. Since in this research self-selection played a role (see SWOV fact sheet *Contents and assessment of traffic education programmes*), no binding conclusions can be derived from it.

In the Netherlands there are various suppliers of driving simulators for training purposes. The simulators bought by driving schools are practically exclusively used for teaching basic skills and not for teaching advanced skills, such as hazard perception. One supplier of driving simulators has developed a hazard perception training. Driving simulators are also used in refresher courses for lorry drivers and hazard perception can be included in these courses. As yet, no study has been made of the effectiveness of these ways of training hazard perception.

All in all, training hazard perception in a driving simulator is certainly an option, but it still needs to be developed more extensively. Furthermore, various evaluation studies have to be carried out before a well-founded assessment can be presented about the best training method and the effects.

Can hazard perception be trained during regular driving lessons?
As far we know, no research has been carried out into training hazard perception during regular driving lessons. This does not mean that hazard perception cannot be included in the driving lessons. Research carried out in Great Britain (Groeger & Clegg, 2000) showed that only 6% of what the driving instructor says in the car concerns visible hazards and the risks of the learner's actions. Not only the driving instructor indicating (potential) hazards is important, but it is also important that the driving instructor allows learners to detect hazards for themselves. A teaching method based on coaching principles appears to be the most suitable one for this. A driving instructor who asks the student what could happen at a particular moment and what would be the best action may be an example. 'Thinking aloud' could also be suitable (Baily, 2009). For example: "I'm now looking sideways from behind this truck, because it is blocking my view. A car may drive up from behind it."

What is the effect of a hazard perception test being included in the driving test?
In the Netherlands, hazard perception has been included in the theory examination of the driving test for passenger cars since 2009. The question is what the implications are for attention paid to hazard perception during the practical driving lessons. In the Netherlands the driving test determines the subjects that will be dealt with during the driving lessons. The same applies for Great Britain, but in the other European countries the situation is different. In those countries, the government can make subjects compulsory for the driving lessons that will not be tested during the driving test. If the driver training is test-determined, the risk may be that the driver training only focuses on passing the driving test. As a result, training hazard perception changes into mastering the tricks for passing the hazard perception test. In this case, hazard perception training will consist of no more than practising the exercise material. Nevertheless, the introduction in 2002 of a hazard perception test in the theory examination in Great Britain has had a small beneficial effect on traffic safety. Wells et al. (2008) established that after the introduction of the hazard perception test, the crash rate decreased by 3% in the first year after having passed the driving test. However, this result should be considered with caution, because the research is based on many assumptions.

Conclusion
Learner drivers appear to gradually learned hazard perception in practice because they find themselves in hazardous situations that frighten them. Various ways have been developed of training hazard perception effectively. One basic principle of this training requires students to predict situations. Computer programmes have also shown to be effective for self-tuition. Hazard perception training in a driving simulator is still in its infancy, but proper hazard perception training in a driving simulator appears to be one of the options. Hazard perception can also be trained in various ways during regular driving lessons. Only including a hazard perception test in the driving test, without meeting requirements for hazard perception training in the driving course, is expected to have a limited effect on learning hazard perception. In that case, training is quickly reduced to no more than learning tricks for passing the driving test.

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