SWOV Fact sheet

Training hazard perception skills

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. Simulator-based training programmes and PC-based training programmes have been developed that clearly improve hazard perception skills. As yet it is not entirely clear whether these improvements are lasting. Furthermore, there are indications that hazard perception training reduces the crash rate of crashes involving young novice drivers, but conclusive evidence is still lacking.

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 and how to test it*). Novice drivers still have difficulties with this skill.

This fact sheet discusses the ways hazard perception may be learned through training. The way in which perceiving hazards is learned while gaining driving experience is discussed first. Then a number of training programmes that have shown to be effective will be discussed; these include courses using films, Computer Based Instruction (CBI) and simulator training. The possibility to train hazard perception during the regular driving lessons is 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 and how to test it*). The question is how novice drivers learn to perceive hazards early enough in the everyday traffic situation. This knowledge is important for developing effective methods for training hazard perception skills.
 Drivers are believed to develop so-called schemata as a result of their experiences in traffic. Schemata (plural of the Greek word schema) are mental representations of successive acts in certain situations. For example, one can see a traffic light turn red and the schema 'traffic light on red' is activated in the brain fully automatically. Without any further thought, based on the schema, all actions that are necessary to come to a halt before the traffic light are carried out. Schemata help drivers to act quickly in situations they recognize and they become active if a driver has to perform the same actions regularly (Anderson 1982). However, a well-known proverb says that 'exceptions prove the rule'. Sometimes it is wrong to act on 'autopilot'. Experienced drivers not only have many schemata, but they are also flexible in applying the schemata. How do these flexible schemata arise whereby one notices that the situation is slightly different and expect it could be dangerous? Damasio (1994) developed the somatic marker hypothesis about this. Somatic markers originate in a familiar situation in which one, based on schemata, acts more or less on autopilot and is rocked by an entirely unexpected hazard that just barely ends well. If one later encounters a similar situation, the somatic marker is activated: we then know without any further thought that a certain danger is to be expected and that we should be prepared.

Training is intended to speed up the process by which hazard perception is learned by practical experience. Before going into the different training methods, we will first discuss how to establish whether or not a specific training is effective.

How can one determine that training has improved someone's hazard perception skills?
If learner drivers have a better score on a hazard perception test after a training than before the training and they also score better than students who attended a placebo training, then one can say

that the training has been effective. A better score on a hazard perception test, however, does not necessarily mean that someone is also better at hazard perception as a driver in everyday traffic. When training also results in better hazard perception in actual traffic, transfer of knowledge and skills to practice is established. But even when transfer takes place, it does not necessarily mean there are also fewer crashes. This is only the case if it has been proved that better hazard perception skills also result in fewer crashes. To date, the relationship between hazard perception training and crash involvement has not been successfully established. One study has shown that learners who had followed a simulator training in which hazard perception played an important role, had a considerably lower crash rate in following years than learners who had not followed the training (Allen, Park & Cook, 2008). However, this study had methodological weaknesses.

Indirectly it has already been found that hazard perception training results in fewer crashes. In fact, some studies have determined that hazard perception training leads to better hazard perception in actual practice (Chapman, Underwood & Roberts, 2002; Palmer et al., 2009). Furthermore, Australian research showed that learners who had scored poorly on the hazard perception component of the theory test were more often involved in serious traffic crashes per distance travelled in the following years than learners who did well at the hazard perception component (Congdon, 1999).

Another factor that determines the success of a training is the retention of trained skills. Does what one has learned also take root? Often a skill turns out to have improved immediately after the training, but is sometimes found to have gone a day. Determining whether a hazard perception training has been effective therefore requires study of transfer as well as study of retention.

The following three sections will successively discuss theory lessons in hazard perception, simulator training in hazard perception and practical training in hazard perception.

Can hazard perception skills be trained without driving simultaneously?
Hazard perception training programmes during which the learner does not drive, usually comprise video clips that have been recorded from the perspective of a driver. These films include situations that could become dangerous. Two methods are used. The first method involves listening to comments and commenting (e.g. Chapman, Underwood & Roberts, 2002; Isler, Starkey & Williamson, 2009; McKenna, Horswill & Alexander, 2006). In this method learners watch the movies taken from the perspective of a driver and listen to the commentary by an experienced driver. This experienced driver says, for example, "I now reduce speed and look at the spaces between parked cars, because this is a neighbourhood with many children and a child that is hidden by the parked cars could cross the road unexpectedly", et cetera. Sometimes the spots where danger may occur are also marked in the film by, for example, circles. In most cases, but not always, the learner then has to comment when watching such a film. The instructor then gives feedback (did you notice…, et cetera). The second method uses the same type of films, but now the film stops and the screen goes on black at the time the first indications of a developing hazard become visible. The instructor then asks the learner to describe the situation and predict what could happen (e.g. Jackson, Chapman & Crundall, 2009; McKenna & Crick, 1997). Next the instructor gives feedback on the predictions made by the pupil. Sometimes a mix of the two methods is used. Wetton, Hill & Horswill (2013) investigated which of the two methods is most effective. It turned out that a half-hour training consisting of the combination of the three elements listening to commentary, giving commentary, and predicting what could happen next, gave the best result. This means that a training in which all three methods were combined showed the largest improvement in hazard perception and also the best retention. To measure retention, testing was repeated a week after the training. Of the three elements, listening to the commentary was found to contribute to the effect the most. The retention was low when only in predicting what could happen next was practiced. Unfortunately no research was done on whether transfer to actual traffic occurred.

Massachusetts University in Amherst developed a number of successful methods in which no films are used: the so-called Risk Awareness and Perception Training (RAPT I, II and III). In RAPT I (Pollatsek et al., 2006) the learner is shown a plan view of a traffic situation on a PC. He then has to image being, for instance, the driver of the green vehicle in that traffic situation and what he would see. Then a red circle has to be dragged to a position on the plan that needs to be observed carefully, and a yellow oval to the position where another road user may be present, but cannot be seen by the driver because that position is screened off. This training mainly focuses on learning to notice possible other road users that can collide whit the driver but cannot be seen because the view is blocked by another

vehicle, or parked cars, or houses, or bushes, et cetera. These are the so-called screened off situations. Prior to the training a pre-measurement is done. This is followed by a training which, again using plans, explains about the dangers. This is followed by a post-measurement. In RAPS III a series of photos of developing traffic situations with hidden dangers is used in addition to maps. If the learner feels that there is a hidden danger is on a picture, he must indicate that spot with a mouse click. Learners can only proceed to the next task when they have clicked on the right spot in the right picture. After a (half-hour) training, both RAPT I and RAPT III resulted in more hidden dangers being identified during a drive in a simulator. During the simulator drive an eye tracker is used to measure whether one looks in directions where nothing special is to be seen, but where traffic on collision course may become visible when it is no longer screened off. As a simulator is used to measure the effect of the training on viewing behaviour, this is called quasi transfer. However, RAPT III has also been shown to improve hazard perception in real life traffic situations (Pradhan et al., 2009). For RAPT III, retention was found to lessen somewhat during the course of several months.

Can hazard perception skills be trained in a simulator?
Some hazard perception trainings have been developed that are given on simple driving simulators and of which the effects have been investigated (Ivancic & Hesketh, 2000; Vlakveld et al., 2011; Wang, Zhang & Salvendy, 2010a; Wang, Zhang & Salvendy, 2010b). The advantage of a driving simulator is that situations can be presented that are too dangerous to practice in real traffic. All these trainings were found to result in better anticipation of traffic hazards. In most simulator trainings (Ivancic & Hesketh, 2000; Wang, Zhang & Salvendy, 2010a; Wang, Zhang Salvendy, 2010b) learners are presented a replay of their reactions in certain situations with hazards that are developing. They learn by talking about their mistakes with the instructor and to discuss how they could have done better. The studies by Ivancic & Hesketh (2000) and by Wang, Zang & Salvendy (2010b) also investigated whether there is a difference between seeing one's own errors and being presented with the mistakes made by others. Learners were found to learn significantly more from their own errors than those made by others.

The method developed by Vlakveld et al. (2011) differs from the other simulator training methods. In the training developed by Vlakveld et al. (2011) learners do not get a replay of their own errors. The training consists of a number of scenarios with hidden dangers. After the first stage of each scenario the learner is asked what could have happened, but did not. Usually he has no idea. Then the same drive is made again, but this time the hidden hazard develops and becomes manifest. This mostly results in a crash or a near crash. Immediately after the crash or near-crash, a plan view of the situation is shown and the learner has to explain to himself the pupils why the crash occurred and how it could have been avoided in time. The learner does this by, for instance, pointing out on the plan the position of the other road user before he/she becomes visible, where the learner should have looked to spot the other road user at the earliest possible moment, and where he should have reduced speed to increase the safety margin.

Then the same drive is made once more to show that one had learned to anticipate on the hidden hazard. After the training of about an hour, a long drive is made in an advanced simulator while an eye tracker measures the direction in which learners look. That long drive contains hidden hazards that sometimes differed only in appearance from the hidden dangers in the training, and sometimes differed conceptually from the hidden hazards in the training. Participants in this study who had followed the training perceived and recognized more hidden hazards than participants that did not attend the training. This was true for both hidden hazards that only looked different and for hidden hazards that were conceptually different (Vlakveld, 2011). Retention was only examined for the training of Wang, Zang & Salvendy & (2010a). After a month the hazard perception skills had declined slightly, but were still significantly better than the hazard perception skills of people who did not follow the training.

Can hazard perception skills be trained during regular driving lessons?
In the UK, a practical hazard perception training was developed by the police. Crundall et al. (2010) investigated whether this method could also be used for driving school pupils. In this training the instructor first takes place behind the steering wheel and the learner sits beside him. While driving, the instructor speaks out loud about what he pays attention to while driving, which hazards are to be expected in specific situations, and what action he takes to avoid these possible hazards. After a while they change places. The learner drives and speaks out loud and the instructor gives feedback. For example: "you say that you were paying attention to that cyclist over there, but did you also notice the

pedestrian on the sidewalk?" Driving school pupils who had taken the practical hazard perception training had significantly better anticipation of latent hazards than pupils who had not. The simulator drive was taken immediately after the practical training. It is therefore unknown if the skills also take root. Another example of a practical training is the one-day advanced training for motorcyclists 'VRO Risk' which was developed by the Royal Dutch Motorcyclist's Association (KNMV). This training expressly does not focus on learning practical skills, but on seeing latent hazards and assessing the risks. In this training an instructor follows a pupil and films his motorcycle ride. After the lesson the film is discussed with the pupil with special attention for whether or not the learner anticipated hidden dangers. Motorcyclists who had taken the training, did significantly better on a hazard perception test with moving pictures (Vlakveld, 2011) than motorcyclists who had not (Boele, De Craen & Erens, 2013). If those who followed the training are still better at hazard perception after one year than motorcyclists who did not take the training is being investigated.

Conclusion

Novice drivers appear to gradually learn hazard perception skills in traffic because they occasionally find themselves in hazardous situations that frighten them. Various ways have been thought of to train hazard perception skills effectively. Several effective computer-based trainings, simulator trainings and practical trainings have been developed. However, often it has not yet been investigated whether the newly acquired skills have taken root and whether transfer to practical application has occurred.

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