

Hazard perception in traffic

Summary

Hazard perception is an essential part of the driving task. There are clear indications that insufficient skills in perceiving hazards play an important role in the occurrence of crashes, especially those involving novice drivers. Proper hazard perception not only consists of scanning and perceiving a hazard in time, but also correctly appraising the seriousness of it and knowing what to do to avert the danger. This not only demands situation awareness, but also self-assessment. There are various methods for measuring the hazard perception skills of drivers. Not all these measuring methods are equally suitable to be used as examinations in the driving test. As various skills play a role in hazard perception, various types of examination should be part of the hazard perception test also. Following Australia and Great Britain, the Netherlands made hazard perception a regular component of the theory examination of the driving test for passenger cars in 2009.

Background and contents

Following Australia and Great Britain, the Netherlands made hazard perception a regular component of the theory examination of the driving test for passenger cars in 2009. This was prompted by the fact that insufficient skills to perceive hazards and to respond to them in time is an important contribution to crashes involving young, novice drivers.

This fact sheet will discuss in detail the theory concerning hazard perception. What is hazard perception? What is the importance of hazard perception for traffic safety? And how can it be measured and tested? A separate fact sheet deals with the possibilities of how to learn to perceive hazards (SWOV fact sheet [Training hazard perception](#)). Detecting hazards as well as reacting to them is important in hazard perception. Until now the emphasis of the international research into hazard perception has been on detecting dangers. This is the reason why this fact sheet contains more information about detection of hazards than it does about reaction to hazards.

What is hazard perception?

Many definitions of hazard perception are used, but there is no definition that experts consider to be the only correct one. Broadly speaking, hazard perception is defined as scanning and perceiving potentially dangerous situations in time and being able to predict the way in which traffic situations will develop. Based on this insight, a driver should be able to decide on the actions to avert the danger in time and, subsequently, to carry out these actions correctly. As a matter of fact, hazard perception consists of far more than merely perceiving a hazard. According to Groeger (2000), four processes play a role in hazard perception:

1. detection of looming hazard;
2. threat appraisal;
3. selection of actions to avert the hazard;
4. implementation of actions chosen.

The *first process* concerns observing, focussing attention on relevant issues, the diagnosis of the situation and predicting the way in which traffic situations will develop. What do drivers look at while driving, how do they scan the traffic situation? Do drivers, for example, adapt their scanning strategies when entering an urban area (by looking right and left more often)? Apart from simple scanning, there is also searching, based on expectations of what may happen. Two different kinds of search can be distinguished: 1) drivers deliberately focus on other road users present who may possibly act dangerously, and 2) they look into directions in which nothing (yet) occurs, but from where hazards may loom all of a sudden. In the first case, drivers look out for explicit hazards and in the second case for hidden ones. An illustration of an explicit hazard is a pedestrian who starts running on the pavement when a bus is slowing down at the opposite side of the road. A driver coming up the road should be able to consider that this pedestrian may well cross the street without looking in order to catch the bus. An illustration of a hidden danger is a passenger, who is not yet visible, but who may cross the road in front of a stationary bus; a car that may come up from behind a lorry is another example. The *second process* concerns threat appraisal, state awareness and risk awareness (see

SWOV fact sheet [State awareness, risk awareness and calibration](#)). A driver who prefers to avoid risks and who feels responsible for other people's safety will appraise the seriousness of a looming hazard differently from a driver who considers danger exciting and who thinks that others should intervene. The *third process* concerns the issue of how to act in the case of a perceived hazard. For instance, would it be best to brake or would it be better to just slow down a little; should one change course or give a signal? Finally, the *fourth process* concerns the implementation of these actions (changing course, braking, accelerating, changing gear).

According to Groeger, these four types of process – and, subsequently, how capable drivers are of implementing them – are not independent of each other; his model is schematically represented in *Figure 1*. The arrows indicate how the one skill has an effect on the other. These effects occur mutually. What drivers are capable of has an effect on what they perceive and this in its turn has an effect on what they are capable of.

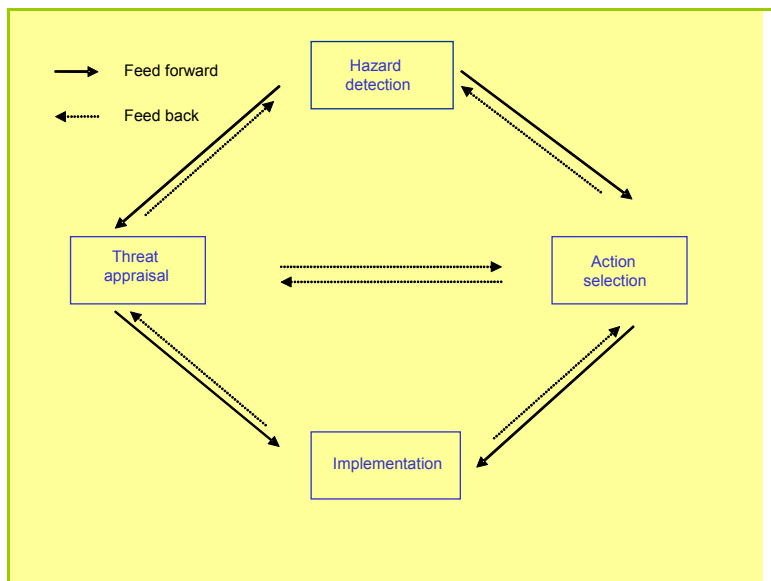


Figure 1. Hazard perception model of Groeger (from Grayson et al., 2003).

Some people are of the opinion that hazard perception is too limited a concept and they prefer to talk about situation awareness. Road users who are aware of the traffic situation know what is going on around them. Endsley (1995) defines situation awareness as 1) perceiving elements in the environment within a specific volume of time and space, 2) comprehending the significance of these elements, and 3) being able to predict what will happen next. These three aspects of situation awareness – perception, comprehension and prediction – also play an important role in hazard perception. For this reason, Horswill & McKenna (2004) maintain that hazard perception and situation awareness are synonymous.

Are all road users equally good at hazard perception?

Only among car drivers it has been extensively studied how good road users are at hazard perception. At first, this was mainly done by examining whether there were variations in the skills between car drivers who had or had not had a crash or fine (for an overview, see Horswill & McKenna, 2004). These studies showed that car drivers who had not been involved in crashes reacted to hazards more quickly than drivers who had been involved in crashes. Later, it has mainly been studied whether there are differences in hazard perception between young, novice drivers and older, more experienced drivers. This research showed that young, novice drivers scan their environment less well in comparison with older, more experienced drivers. Young, novice drivers often scan the distant traffic situation less well. They also scan the wider perspective less well and they look longer before acting upon hazards. Finally, young, novice drivers scan the directions from which looming hazards may occur less frequently (for an overview, see Jackson et al., 2009).

Not only differences in scanning behaviour, but also differences in the time it took for drivers to react to hazards have been studied. The results are not uniform. According to research by McKenna & Crick

(1997) and Sexton (2000), it took longer for younger, novice drivers to react than it took older, more experienced drivers. Chapman & Underwood (1998), on the other hand, found no noticeable differences in the time it took for novice and more experienced driver to react. Sagberg & Bjørnskau (2006) found no differences in reaction time with respect to 'common' hazards, but in the case of more complex hazards more experienced drivers reacted more promptly than young, novice drivers did.

Recently, more attention has been paid to hazard perception among older drivers. Horswill et al. (2008) found that drivers aged 65 and older reacted to hazards considerably later than middle-aged drivers did. These differences in reaction time turned out not to relate to a lesser skill in predicting the way in which traffic situations will develop, but to a reduction of visual perception. In particular, the diminished eyes' contrast sensitivity and a lesser ability to process visual information are to blame.

What is the role of hazard perception in the occurrence of crashes?

A large number of studies have explicitly examined the relation between hazard perception and traffic safety. Most studies conclude that a correct perception of, in particular, complex and hidden dangers improves in the course of becoming a more experienced driver, and that this results in a reduced crash rate.

Having analyzed 2,000 crashes in which young, novice drivers in the United States were involved, McKnight & McKnight (2003) concluded that not noticing and perceiving hazards early enough had played a role in approximately 44% of those crashes. With respect to the remaining crashes, the young, novice drivers were mainly distracted (23%), or they drove too fast for the prevailing conditions (21%). Australian research (Congdon, 1999) showed that novice drivers who are bad at hazard perception run a greater risk of being involved in a fatal crash, compared to novice drivers who are good at hazard perception. Dutch research (Vlakveld, 2008) showed that young, novice drivers with at least one self-reported crash were less good at perceiving, as well as reacting to hazards, compared to young, novice drivers without a crash record.

The initially high crash rate of young, novice drivers is known to decrease as they become more experienced (see SWOV fact sheet [Young, novice drivers](#)). This decrease may possibly relate to an improved hazard perception due to increased experience. Indeed, there are a number of studies indicating this. During the first few years after having passed the driving test, hazard perception improved (Fisher; et al., 2002; Whelan et al. 2004). Sagberg & Bjørnskau (2006) also found that hazard perception improved during the first year of having a driving licence, but this applied only to the perception of complex, hidden dangers and did not apply to the perception of directly visible dangers. Vlakveld (2008), on the other hand, found no improvement of hazard detection in the period immediately after having passed the driving test. Additional research which has not yet been published indicates that this outcome is quite likely the result of the research method. Drivers were asked to click the mouse on potentially hazardous situations on a computer screen. It turned out that experienced drivers were hardly better at this than young, novice drivers. However, when experience with computer games was compensated for, the difference was significant indeed. Most research results therefore indicate that hazard perception of particularly complex and hidden hazards improves when drivers become more experienced and that the crash risk diminishes accordingly.

How can hazard perception be measured and is it useful to include it in the driving test?

According to Grayson et al. (2003) the four aspects of hazard perception in the Groeger model (see *Figure 1*) each require a different way of measuring. Below follow the possible measuring methods of these four skills.

Hazard detection

When measuring hazard detection, it is examined whether respondents look in the direction of already visible, explicit hazards and in the direction of potential, although still hidden dangers. Do they scan on the basis of realistic expectations concerning hazardous situations that may occur? This is done, for instance, by having respondents drive in a driving simulator, while their eye movements are measured with a so-called eye-tracking device. With a simpler method, the eye movements can also be registered while the respondents watch films that have been shot from the perspective of somebody driving a car. The disadvantage of eye tracking is that this can only be used in a laboratory situation and not during the driving test.

Another, frequently applied method does not need eye tracking. With this method, respondents (also) watch films that are shot from the perspective of a driver. Next, they have to press a button the moment they think a hazardous situation will occur. It is measured how long it takes before respondents press the button from the moment that the first indications of a looming hazard have become visible. A disadvantage of this method is that it cannot be derived from the reaction times why a respondent has pressed the button. This may have been because of the first signs of a looming hazard, but may also have been for a completely different reason. Neither can this method be used to measure well the respondents' skills in detecting *hidden* dangers.

Detection of hidden dangers can be measured using a method in which the film is stopped and respondents are asked about what may happen next. Jackson et al. (2009) used this method and found that older, more experienced drivers were capable of correctly predicting hazardous situations more often than young, novice drivers. The effectiveness of a variant of this method has recently been studied in the Netherlands as well (Vlakveld, to be published). In this method, each film showed a situation that may become hazardous. The hazards never became manifest. After each film the respondents were asked about what could have happened. Older, more experienced drivers were noticeably better at this than young, novice drivers. A disadvantage of this method is that respondents have to give descriptions and that there are no closed response categories. This makes this method less suitable for use during the driving test.

Threat appraisal

In order to measure the extent to which road users are capable of appraising the seriousness of a hazard, Grayson et al. (2003) consider it of prime importance to know whether the driver is a show-off with little sense of responsibility, or somebody avoiding risks and feeling responsible for other people's safety. These kinds of issues can be measured by means of psychological tests, such as personality questionnaires, tests measuring attribution (are others always blamed for something or are personal shortcomings recognized as well) and the sensation-seeking questionnaire by Zuckerman (1995). A disadvantage is that these tests cannot be used as part of the theory examination of the driving test. Psychological tests may possibly be used when measuring fitness to drive (for the difference between fitness to drive and driving skill, see SWOV fact sheet [State awareness, risk-awareness and calibration](#)).

Selection of actions to avert the hazard

The hazard perception test that was included in the theory examination of the driving test for passenger cars in the Netherlands in 2009 is an example of a selection-of-actions test. During the test, candidates are presented with 25 photos that were shot from the driver perspective. Each photo is shown for eight seconds. During this time candidates have to indicate whether they would in this situation: brake, release the accelerator or drive on at the same speed. 'Braking' corresponds with acute hazards that will result in crashes if the driving speed is not reduced immediately. 'Releasing the accelerator' corresponds with potential hazards that are not (yet) visible (hidden hazards). 'Not changing the driving speed' corresponds with situations in which there is no acute hazard, nor a hidden one. Research by Vlakveld (2008) shows that well-experienced drivers perform better in this test than novice drivers, and that young, novice drivers without a crash record perform better than young, novice driver with a crash record. A disadvantage of this test is that not only the action to avert a crash is tested, but also implicitly the detection of the hazard and the appraisal of the seriousness of the hazard. For instance, if a candidate answers incorrectly that he/she will drive on at the same speed, whereas the correct answer is 'releasing the accelerator', the candidate may not have noticed the hazard (the first process). It may also be the case that the candidate has noticed the hazard, but overestimates him/herself and underestimates the hazards (the second process).

Carrying out the action

During the practice part of the driving test it is assessed how the action is carried out. A disadvantage is that not all candidates meet the same hazardous situations during the driving test. A more accurate assessment of a candidate's skills in averting hazards could be achieved by using a driving simulator.

Conclusion

Hazard perception consists of more than perceiving and detecting hazards. It also involves appraising the seriousness of the hazard, and knowing how to act in order to avert the hazard. There are clear indications that a lack of hazard perception plays an important role in the occurrence of crashes, especially with respect to novice drivers. Although hazard perception consists of various types of

processes, the research into hazard perception has mainly focussed on hazard detection. Various methods have been developed for measuring hazard perception. Not all methods are equally suitable for being included in the theory examination of the driving test. As various skills play a part in hazard perception, a hazard perception test should be composed of various sub-tests, each measuring a different aspect of hazard perception.

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