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SWOV Fact sheet

State awareness, risk awareness and calibration

Summary

State awareness is a new principle in the advanced vision of Sustainable Safety. In contrast with the three original principles, state awareness focuses on the role of the individual in the prevention of crashes and/or injury. *State awareness* means knowing what you are capable of – how good do you think you are, and how good are you really? State awareness cannot be separated from risk awareness. *Risk awareness* means knowing how dangerous the traffic situation is in which you find yourself – how dangerous do you think it is, and how dangerous is it in reality? State awareness is insight into *task capability*, whereas risk awareness is insight into *task demands*. However, this insight does not automatically result in safe behaviour. These two aspects need to be combined: one should ask oneself the question 'can I cope with this dangerous situation?', and adapt one's behaviour if necessary. This is called *calibration*. To a large extent, the calibration process allows road users to influence the difficulty of the task they have to perform in traffic. They can therefore contribute to road safety themselves. At this time, not enough is known about how good the state and risk awareness and calibration of road users is. Almost all the research carried out in this field focuses on young, novice drivers. That research provides cautious suggestions regarding measures that could be successful in improving the state awareness, risk awareness and calibration of road users. However, more knowledge is required on the state awareness, risk awareness and calibration of other types of road users such as cyclists and professional drivers, and of temporary and chronic limitations of fitness to drive as a result of, for instance, distraction or disorders such as dementia.

Background and content

In addition to the three original principles of a sustainably safe traffic system, two new principles – (social) forgivingness and state awareness – have been introduced in the advanced vision of Sustainable Safety (*Advancing Sustainable Safety*; Wegman & Aarts, 2006). In the following years, these principles have been defined in more detail.

This fact sheet explains the term state awareness and the role it plays in safe traffic participation. However, in addition to state awareness, risk awareness and calibration are also important. Moreover, these three terms are closely linked. This fact sheet is therefore not only about state awareness, but also about risk awareness and calibration. For more detailed information about these terms, we refer to the original report by Davidse et al. (2010).

The SWOV fact sheet *Social forgivingness* (to be published) discusses the other new principle. All of the principles are discussed in SWOV fact sheet [Background of the five Sustainable Safety principles](#).

What is the meaning of state awareness, risk awareness and calibration?

State awareness means knowing one's capabilities. More formally, it is the degree of concurrence between one's own perception of one's task capability and what it really is – how good does someone think he is, and how good is he in reality (see *Figure 1*)? The more this coincides, the better the state awareness. In turn, *task capability* is the sum of the road user's driving skill and fitness to drive.

Driving skill is the result of learning and gaining experience, and is related to vehicle control and traffic insight. *Fitness to drive* is related to the temporary and permanent physical and mental state of the road user – is he healthy, well rested, attentive, and not under the influence of alcohol, drugs or medication?

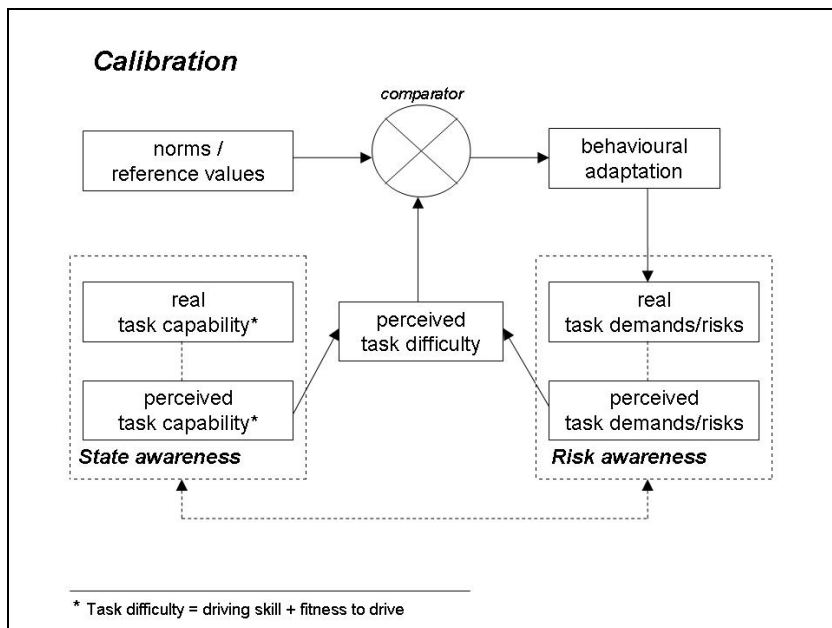


Figure 1. Diagram of the relationship between state awareness, risk awareness and calibration.

Risk awareness means knowing how dangerous the traffic situation is in which you find yourself. It is also called hazard perception. In formal terms, risk awareness is the degree of concurrence between the perceived task demands and the real ones – how dangerous does someone think it is, and how dangerous is it really? The more they coincide, the better the risk awareness. Whereas state awareness is about task capability, risk awareness is about task demands. However, being aware of your abilities and knowing how dangerous a situation is, does not automatically result in safe behaviour. These two things also have to be combined (can I cope with this dangerous situation?), and behaviour has to be adapted if necessary. This is called calibration.

In brief, *calibration* is adapting the traffic task based on a comparison of the estimated task difficulty (how difficult is the task and how good am I?) with a reference value. This is based on many processes including state awareness and risk awareness (see Figure 1). In the first instance, road users – consciously or unconsciously – assess their own task capability (state awareness) and the task demands, that is the complexity and/or hazards of the traffic task (risk awareness). The difference between the perceived task capability and the perceived task demands corresponds with the task difficulty. If you believe that you are more than a match for the task, you will find the task relatively easy – the task difficulty is low. On the other hand, if the task demands more from you than you think you can cope with, you will find the task (too) difficult – the task difficulty is (too) high. The estimated task difficulty will or will not then result in action. This depends on a comparison with a reference value. The reference value is also called the standard or threshold value, which can vary from person to person and from moment to moment. When a road user thinks that the traffic task is more difficult than he can cope with at that moment, or that the traffic task holds more risks than he is willing to take, he will adapt his behaviour in such a way that it becomes less difficult or risky. For instance, he will drive more slowly, choose a different route, or decide not to participate in traffic at all. In such a case, the reference value is 'what can I cope with at this instant?', or 'what risk am I prepared to take?'. If he thinks that the difficulty of the task is acceptable, he will not adapt his traffic behaviour. This entire process of state awareness, risk awareness, estimating the task difficulty, comparison with a reference value, and whether or not to adapt behaviour, is called calibration. Via this process of calibration, road users exert an important measure of control over the difficulty of the task they have to perform in traffic. The more accurate the state and risk awareness, the better the calibration will be.

How can we measure how well people can do this?

State awareness can be measured in two ways:

- 1) via a questionnaire in which people have to compare their proficiency at a task with that of others (e.g. with an average driver or a road user of the same age);

- 2) via a comparison of their own estimated task capability (how many mistakes do you think you might make during this test) with the objectively measured 'real' task capability (how many mistakes did that person really make).

The first method of measuring has a number of drawbacks. Firstly, people not only have to estimate their own task capability, but they must also make an estimate of the performance of another group. Supposing one had to compare one's own performance with that of the average driver, how is the 'average driver' defined? Interpreting the results is also difficult. If someone states that he is a very good driver, is he overconfident or is he really a very capable driver? For this reason, the second method for measuring state awareness is preferable. This can for instance be done by asking drivers to estimate how well they will perform a particular task – at that particular moment – and then comparing that estimate with their real performance.

Risk awareness or hazard perception actually consists of four different skills. Each of these skills is measured in a different way. What these skills are and how they are measured is described extensively in the SWOV fact sheet [Hazard perception](#). Reaction time tests and behaviour choice tests are two examples of measuring methods applied to risk awareness.

During the *reaction time tests* for measuring hazard detection, the test candidates are shown a video taken from the driver's perspective. As soon as they think there is danger, they must press a button. The length of time is measured that the candidate takes to press the button after the first signs of a hazard were visible.

Behaviour choice tests are designed to ascertain whether people take the right measures to avert danger. A video fragment is stopped at certain moments during the showing. The test candidates must then state what they would do at that moment (for instance brake, release the throttle, or do nothing). A disadvantage of this method is that it is not possible to ascertain whether the action or measure chosen is also determined by other skills such as hazard detection and assessment of the degree of danger.

As *calibration* is about adapting the traffic task, you would have to measure changes in behaviour and changes in intended behaviour in order to measure calibration, for instance, whether a driver drives more slowly in a complex or hazardous traffic situation or not. However, in order to chart the calibration process, the results of these measurements must always be linked to the quality of state and risk awareness, for good calibration is only possible if state and risk awareness are adequate. If calibration is not adequate – a driver overtakes a bus that has just stopped at a bus stop at a speed of 50 km/h – then you will also want to know the reason. Did he not see the hazard, was he not aware of the danger, or did he overestimate his driving skills?

Why is state awareness important to road safety?

State awareness is important because the task capability of a road user may vary from one moment to the next, but also during the road user's career. Before participating in traffic, he must, consciously or unconsciously, always check how capable he is of participating in traffic. Risks can also change from one moment to the next, and road users must also take that into account.

But precisely what does 'changes in task capability' mean? As mentioned previously, a road user's *task capability* is the sum of his driving skill and his fitness to drive. *Driving skill* is gained by learning to cycle or drive. The learning process can be formal (for instance via a driving course), or informal (learning by experience while carrying out a traffic task). *Fitness to drive* is related to the physical and mental characteristics of the road user. Fitness to drive can diminish if certain functions gradually decline or fail due to illness, disorder or old age. In such a case, a driver's fitness to drive is said to be chronically limited. Fitness to drive can also be temporarily reduced. This can, for instance, be the case when psychoactive substances are used (alcohol, drugs, or medication), be due to fatigue or indisposition, but also due to stress, distraction, or reduced concentration.

For example, if someone takes driving lessons at the age of 18, he does not yet have the driving skills for that mode of transport. If he is healthy, well rested and has not used alcohol, drugs or medication, he is fit to drive. After many lessons and a number of years' driving experience, this person has also become a skilled driver. His fitness to drive then depends on his behaviour. As long as he has not used alcohol or drugs before getting into the car, starts the journey well rested, keeps his eyes on the road and does not use the telephone, he is fit to drive. If he does not abide by this, his fitness to drive may be temporarily (or acutely) limited. As people grow older, there is a greater chance that the road

user will develop one or more illnesses or disorders. These illnesses and disorders can limit a driver's fitness to drive. As these limitations are permanent, they are said to be cases of a chronic limitation of fitness to drive. Although these limitations may make driving difficult, drivers can compensate for them in many cases, for instance by only driving during daylight in the case of night blindness. Certain illnesses, such as dementia and Parkinson's disease, will often ultimately result in a definite unfitness to drive. In such cases, a person's driving career comes to an end.

Although the above examples concern drivers, they also apply to other means of transport. After all, walking and cycling also have to be learned, and limitations in fitness due to, for instance, alcohol use or balance disorders can also apply to them. However, much of the research into state and risk awareness focuses on drivers. In the following paragraphs, the emphasis is therefore on the state and risk awareness and calibration of drivers.

How good is the state and risk awareness of road users?

The quality of the state and risk awareness of four groups of road users is discussed: fit and experienced road users, novice road users, road users with temporarily limited fitness to drive, and older road users with chronically limited fitness to drive. The conclusions below are based on many studies. The literature consulted can be found in Davidse et al. (2010).

Fit and experienced road users

As yet, not much is known about the state and risk awareness of average, i.e. fit and experienced road users. Most of the research focuses on novice drivers. 'Average' road users are only used as a reference group – is the novice driver worse or just as good as the average driver? Naturally, this also provides some insight into the state and risk awareness of fit and experienced road users.

Where state awareness is concerned, the broad picture is that the average driver is generally very positive about his skills when comparing them to those of other people. Overestimation appears to be greater for certain aspects of the traffic task, such as 'behaving safely'. For actions on which one receives immediate feedback, such as parking, drivers are less inclined to overestimate their skills.

Where risk awareness is concerned, it is shown that older, more experienced drivers usually perform better at hazard recognition tests than young novice drivers. Drivers who have never had a crash or a fine also turn out to detect danger more quickly than people who have. The average driver also appears to be reasonably aware of weather conditions that can affect hazards, such as rain, fog and slippery conditions. However, the resulting adapted behaviour (calibration) is not always correct.

Young, inexperienced road users (with limited driving skills)

Studies of the state awareness of novice drivers do not provide a consistent picture. Some studies conclude that novices overestimate their driving skill more than experienced drivers do, other studies find no difference, and others again conclude that experienced drivers overestimate their driving skill more than novice drivers do. Amongst others, this is due to the measuring methods applied. Different measuring methods provide different results.

There is greater consensus where risk awareness is concerned. Almost all the studies of risk awareness indicate that older, more experienced drivers perform better on the risk awareness tests than young novice drivers do. For instance, experienced drivers are better at reaction time tests and behaviour choice tests than inexperienced drivers are, and older, more experienced drivers evidently scan a larger part of the surroundings and look further ahead than novice drivers do. Research has also shown that young novice drivers with bad scores for hazard perception in their theory examination are more likely to be involved in a serious crash than young novice drivers who achieved high scores for their hazard perception test (Congdon, 1999). Incidentally, hazard perception can be learned. This is also the reason why it is, or is going to be included in driving courses and theory examination for driving licence B in various countries. In the Netherlands, hazard perception has been included in the theory examination for driving licence B since 2009 (for more information see the SWOV fact sheet [Hazard perception](#)).

Road users with temporarily limited fitness to drive

A road user's fitness to drive can vary from one moment to the next and from day to day. Temporary factors that may affect a driver's fitness to drive can be fatigue, alcohol use, and distraction. Although a fair amount of research has been devoted to these factors and their effect on driving behaviour, little is known about whether road users are aware of the effect of these factors on their own fitness to drive. It is apparent however, that drivers do not always have the right information. For instance, many drivers believe incorrectly that hands-free telephoning is much less dangerous than hand-held.

Sometimes it even seems that they are not at all aware that a particular factor (for instance fatigue or emotions) affect one's fitness to drive. It is therefore important to investigate not only the effects of certain factors on fitness to drive, but also to examine how aware road users are of their effects, and whether they take them into account. It is then important to consider how drivers can be made aware of the factors that affect their fitness to drive, and how they can be induced to do something with this insight and take the right actions.

Road users with chronically limited fitness to drive

As people grow older, there is an increased possibility of illnesses and disorders that limit their fitness to drive. Examples of such disorders are dementia, Parkinson's disease, diabetes, and visual impairments such as cataracts. There is also the likelihood that general functions deteriorate, such as slower reactions, problems with dividing one's attention, and increasing difficulty with night vision. Many older road users appear to be aware that their fitness to drive is becoming limited, and adapt the traffic tasks they undertake accordingly (calibration). For instance, older drivers will often avoid driving during rush hour, or will no longer drive in the dark. However, there has been hardly any research into whether the older people who adapt their behaviour actually suffer from functional impairments that would make this necessary. People with cognitive function impairments such as dementia, are known to find it difficult to perceive their reduced capabilities, or to adapt their traffic behaviour to their reduced abilities.

Which measures relate to the Sustainably Safe principle of state awareness?

Safe traffic behaviour requires good state awareness, good risk awareness, and good calibration. As a road user, you must know your capabilities, you must be able to recognize hazardous situations, and you must adapt your behaviour if you are unable to perform a traffic task safely under the conditions reigning at that moment. A road safety policy that strives to achieve a sustainably safe traffic system can support road users in all of these aspects in different ways. The available literature provides cautious suggestions, although more detailed research is necessary.

The *state awareness* of road users can be improved by:

- providing feedback regarding traffic behaviour during driver training, but possibly also subsequently with the aid of technical systems inside the vehicle;
- providing information regarding the factors that affect fitness to drive: apart from alcohol, drugs and medication, there are also factors such as fatigue, emotions, and distraction; and
- helping drivers to assess their own fitness to drive via a (still to be developed) reliable and valid test procedure.

The *risk awareness* of road users can be improved by:

- paying attention to hazard perception during driver training, and including a hazard perception test in the theory examination for all driver's licences;
- providing information regarding the factors that can affect the hazard and must be recognized as such, for instance weather conditions; and
- technical systems inside the vehicle that, for instance, warn against a slippery road surface or fog, but also against unexpected traffic situations such as traffic jams or road works, and obscure traffic situations.

The *calibration* of road users could possibly also be improved via driver training and information.

However, it is at least as important that a road user is given the opportunity to adapt his behaviour in the desired direction. A road user who does not feel able to drive a car in the dark, can decide to use public transport. In that case however, public transport must also be available. For older road users in particular, it is important that alternative means of transport are available that are easily accessible and affordable, and provide the opportunity to travel spontaneously to any desired destination. Where commercial transport is concerned, it is important for an employer to provide the necessary space for his employees to undertake the necessary behaviour changes (not driving when fatigued), and by placing safety above economic interests (concern for safety culture).

What additional research is required?

The research into state awareness, risk awareness and calibration that has been carried out up to now has evidently concentrated on a small section of the research population. In terms of types of road users that are observed, it is mostly limited to novice drivers. In terms of factors that affect task capability, the emphasis is on limitations regarding driving skill, and much less on limitations affecting

fitness to drive. In order to gain a broader picture of the state and risk awareness of road users, it is therefore recommended to focus future research of state awareness, risk awareness and calibration on other types of road users (for instance cyclists and professional drivers), and on state awareness with regard to temporarily and chronically limited fitness to drive (for instance resulting from distraction or disorders such as dementia). Relevant research questions are: To which extent are road users aware of the effects of factors that can affect their fitness to drive or the risk? Do road users adapt their behaviour sufficiently? What measures would be effective to make them aware of factors that affect their fitness to drive, and how can we motivate them to actually do something with this insight and act correctly?

Conclusions

The Sustainable Safety principle of state awareness is about insight into one's own limitations. However, we cannot separate state awareness from risk awareness and calibration. Safe behaviour in traffic requires good state awareness, good risk awareness, and good calibration. You have to know your capabilities, you must be able to recognize hazardous situations, and you must adapt your behaviour if you are unable to carry out the traffic task safely under the conditions reigning at that moment. At this time, not enough is known about how good road users' state awareness, risk awareness and calibration are. Almost all the research into these subjects has focused on young novice drivers. That research gives cautious suggestions regarding measures that could be successful in improving the state awareness, risk awareness and calibration of road users. However, there is a need for more knowledge, in particular regarding state awareness, risk awareness and calibration with other types of road users, such as cyclists and professional drivers, and in cases of temporarily or chronically limited fitness to drive resulting, for instance, from distraction or debilities such as dementia.

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