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BEDRIJFSECONOMISCHE WETENSCHAPPEN

master in de verkeerskunde: verkeersveiligheid
(Interfacultaire opleiding)

Masterproef

Training hazard perception of young novice drivers - A driving simulator study

Promotor :
Prof. dr. Elke HERMANS

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Masterproef voorgedragen tot het bekomen van de graad van master in de verkeerskunde , afstudeerrichting verkeersveiligheid

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KNOWLEDGE IN ACTION

TRAINING HAZARD PERCEPTION OF YOUNG NOVICE DRIVERS - A DRIVING SIMULATOR STUDY

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ABSTRACT

Objective: The goal of this study was to determine whether young novice drivers that were trained in hazard perception (i.e. specified hazard detection and hazard handling skills) performed better than young novice drivers that did not receive training, immediately after training and two to four weeks after receiving the training. *Participants*: young novice drivers between the age of 17 and 25 that held their temporary or permanent driver's license were randomly assigned to a training intervention or a control intervention. The pretest, training or control intervention and the posttest that were all conducted on the first testing day took approximately two hours to complete. The follow-up test that was conducted two to four weeks later, took about one hour to complete. The effects of training were assessed in a driving simulator by tracking participants' eye movements. *Results*: The hazard handling scores were significantly higher for the trained group, as indicated by a significantly higher percentage of rear mirror use, and this effect persisted over time. In hazard detection, evaluated by means of detection time, correct hazard detection and occurrence of collision, the trained group performed significantly better in detection time and correct hazard detection during the posttest and retention test.

Keywords: Hazard perception, Young novice drivers, simulator-based training, eye-movements

1. INTRODUCTION

Despite a positive evolution in the number of accidents, Belgium still has a high death rate compared to the safest European countries. In 2008, Belgium was listed 15th of a total of 27 European member states (Casteels & Nuyttens, 2010). In 2009, Belgium had a total of 944 traffic deaths, 17% of these fatalities where young drivers between the age of 18 and 24 (BIVV, 2011). In relation to their participation in traffic, young drivers between the age of 18 and 24 are overrepresented in the accident figures in Belgium and other countries (Bos et al., 2006; Chan et al., 2010; Daniels, 2007; OECD & ECMT, 2006; Safetynet, 2009; SWOV, 2010a; Vidotto et al., 2011). Not only young drivers, but especially young inexperienced drivers have a high risk of crash involvement (Harrison, 1999). This higher risk for young novice drivers can be attributed to different causes (Arnett, 2002; Vlakveld, 2011). Beside the age factor, present study will focus on experience and hazard perception.

Driving is a complicated task and it is accompanied with certain risks. Apart from performing numerous motor tasks, drivers need to monitor other road users, various elements from the environment and the traffic situation as a whole. By doing this, they can detect elements and traffic situations that could form a threat, also referred to as hazards. "A hazard is a situation or activity in which danger will occur with some probability" (Michon, 1978). Grayson et al. (2003) created a basic model of hazard perception which explains that it consists of hazard detection, threat appraisal, action selection and implementation.

"Different studies have depicted the importance of hazard perception in traffic safety" (cited in (Crundall et al., 2010)). McKnight and McKnight (2003) identified the failure of appropriate visual search as a leading cause for crashes (cited in Pradhan et al., 2011) and according to Chapman & Underwood (1998) "hazard perception abilities represent the most promising perceptual or cognitive predictors of road-traffic-accident involvement". Hazard perception does not only play an important role in traffic safety in general, poor hazard perception abilities have been attributed to the high crash rate of young drivers. Hazard perception of young novice drivers plays an important role in traffic safety since this group has fewer hazard perception abilities to detect and recognize potential hazards. Additionally they lack skills to subsequently respond appropriately to those hazards, in comparison with more experienced adult drivers (Grayson et al., 2003). Pradhan et al. (2011) stated that the high crash risk of novice drivers can be partly attributed to their underdeveloped hazard perception abilities. Several other studies confirm this relation between hazard perception skills and crash risk of young novice drivers (Horswill & McKenna, 2004; Pollatsek et al., 2006). "Experience plays an important role in the development of driving skills" (Harrison, 1999) and according to Pradhan et al.(2011) and Underwood et al. (2003) hazard perception skills improve with experience. Different studies have depicted that experienced drivers detect and predict hazardous situations better than novice drivers (Borowsky et al., 2009; Borowsky et al., 2010; Chapman & Underwood, 1998; Crundall et al., 2010; Deery, 1999; Taylor et al., 2011). According to Deery (1999) and Borowsky et al. (2010), experienced drivers perceive hazards more holistically than novice driver (i.e. they see hazards within the context of the traffic situation as opposed to an independent element) and this holistic perception improves with knowledge and experience.

Driving a vehicle can be seen as a hazardous activity, but it will not always evolve into a hazardous situation or a crash. It can therefore take some time to experience different types of hazards in different traffic situations. To speed up this process of gaining experience in hazardous situations and the process in which hazard perception is learned, hazard perception can be trained (Allen et al., 2005; SWOV, 2010b). To conclude, [1] since young novice drivers have higher accident risk (Berg, 2006; Underwood et al., 2003), [2] they have lower hazard perception skills (Borowsky et al., 2009; Chapman & Underwood, 1998; Underwood, 2007), [3] hazard perception is an important skill for traffic safety (Chapman & Underwood, 1998; Horswill & McKenna, 2004; Shahar et al., 2010) and [4] hazard perception skills improve with experience (Pradhan et al., 2011; Underwood et al., 2003), the importance of hazard perception training has not gone unnoticed. There have been numerous attempts to improve hazard perception through various methods of training.

2. THEORETICAL BACKGROUND

2.1 Hazard perception model

In traffic safety, hazard perception is one of the most important skills (Grayson et al., 2003; Vidotto et al., 2011) and it consists of more than merely the ability of detecting a dangerous situation. According to Grayson et al. (2003), hazard perception consists of four components: hazard detection, threat appraisal, action selection and Implementation.

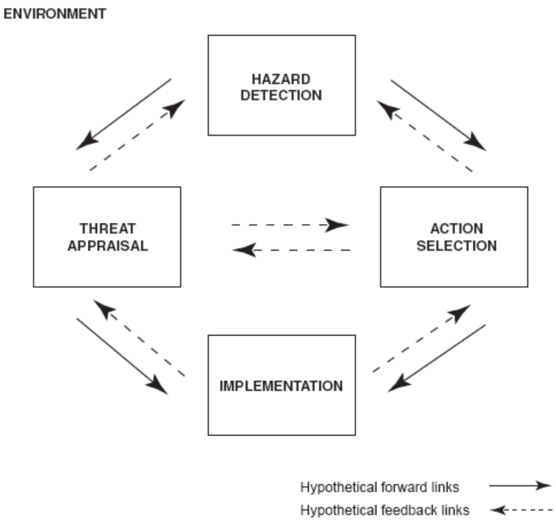

FIGURE 1 The hazard perception model of Grayson et al. (2003)

According to their model, the process of response towards a hazard starts with the detection of a looming hazard. The process of hazard detection is followed by an evaluation of the importance of the hazard in which the driver assesses the potential need for an evasive action. It is speculated that the contribution of this so called threat appraisal to the capacity of a driver to detect and respond to a hazard will decline with an increase of experience. This can be inferred from the fact that well-learned risks may not require a threat appraisal process (Grayson et al., 2003). Once the driver has decided whether to respond or not, he or she will have to select a suitable action within the range of his/her skills. Once the action has been selected, it still has to be correctly implemented. Thus it is not sufficient to detect a hazard; necessary skills need to be implemented in order to obtain a safer driving behavior.

2.2 Hazard perception training studies

In the experiment of McKenna et al. (2006) the effect of hazard anticipation training on risk-taking behavior was examined. In their training intervention, participants were asked to generate verbal commentaries and listen to the commentary of experts while they watched videos of hazards that were filmed from a driver's point of view. This simple training using only comments, resulted in shorter reaction times. However, the researchers did not take into account that in on-road driving, drivers cannot devote their attention entirely towards hazard perception. The study of McKenna et al. (2006) only analyzed reaction times in order to evaluate the effect of the training program on hazard anticipation. Furthermore their experiment did not contain a pretest, thus they have no knowledge of initial differences between the trained and untrained group.

Making use of comments while watching videos is a training technique that was also used by Isler et al. (2009), in order to improve the hazard perception skills of novice drivers. In their training, participants had to press a button when they detected the onset of a developing hazard and verbally identify that hazard immediately afterwards. When a hazard was detected and correctly identified, the button click was used to calculate the reaction time. This study did attempt to compensate for the fact that the attention of drivers is divided over various elements. This was done by making use of a secondary task, which consisted of a central tracking task, simulating the steering aspect of real driving. After the training, the number of hazards that were detected correctly was significantly higher than that of the control group and the reaction times of the trained drivers improved.

Chapman et al. (2002) aimed to design a training intervention to improve newly qualified drivers' visual search strategies. In their training method they made use of videos that were filmed from the driver's perspective. This intervention took one hour to complete and it consisted of five phases, which were presented in the following order: 1. initial commentary: producing commentary while watching the videos and pressing a response button as soon as danger was detected; 2. visual search task: [a] producing commentary while watching the videos running at half speed in which hazards were marked, [b] watching the same video with expert comments; 3. anticipation and hazard processing task: [a] predicting what could happen when the videos were paused, [b] listening to prediction of experts; 4. skill development: same as the second phase but films running at full speed; 5. unsupported commentary: repetition of phase one with new videos. Chapman et al. (2002) evaluated the effect of training on the actual eye gazes of the participants. After training, the trained group showed an increase in horizontal search in real traffic. This result, however, did not persist over time (three to six months after training). Based on the results, Chapman et al. (2002) concluded that the intervention was successful in improving scanning behavior due to that increase in horizontal variances. This study analyzed the effect of the training intervention on visual search and its effects over time, but did not make a distinction between near and far transfer scenarios. Transfer is the degree to which the participants apply what they have learned during training in on-road driving. Two components can be distinguished: near transfer and far transfer (Fisher, 2006; Vlakveld, 2011). Near transfer occurs when the trained participants apply what they have learned in situations that contain hazards that are conceptually identical to the training situations. In far transfer, participants apply what they have learned in situations with hazards that conceptually differ from that of the trained situations (Deery, 1999; Pollatsek et al., 2006; Vlakveld, 2011). Transfer is one of the most important elements for the evaluation of a training program (SWOV, 2010b; Vlakveld, 2011). It could be interesting to analyze the difference of the effect between near and far transfer to optimize a possible integration of hazard perception training in a driving education system. Since participants were also not required to control a vehicle while watching the videos in training, it is possible that this made it easier for them to adjust their visual search strategies (Chapman et al., 2002).

2.3 Simulator based hazard perception training studies

The hazard perception training studies mentioned above showed some positive training effects, however, they did not make use of a driving simulator to assess these effects in a more realistic and controlled environment. Simulator-based training interventions can have some advantages over a pc-based or video-based training method. Unlike the aforementioned pc-based studies, simulator-based studies provide the opportunity to experience hazardous situations and their consequences more realistically, whilst the safety of the drivers is preserved (Allen et al., 2005; Brooks et al., 2010; Kaptein et al., 1996; Riener, 2011). Another advantage is the fact that participants have to allocate their cognitive resources, which means that they cannot focus merely on hazard perception (Vlakveld, 2011). Shahar et al. (2010) also stated that if participants are provided with a wider field of view, it includes more environmental cues that are related to a hazardous situation and increases their ability to detect hazards. Chapman et al. (2002) also stressed the need for scanning multiple locations in the visual scene for sources of potential danger, which can hardly be achieved with one screen.

Chan et al. (2010) concluded that driving simulators are useful in differentiating the behaviors of drivers in hazard anticipation. In addition, Pradhan et al. (2005) concluded in their study that the use of a simulator in combination with an eye tracker plays an important role in the assessment of drivers' risk recognition. This is due to the fact that eye movements provide clear evidence of recognition of risks.

In the study of Crundall et al. (2010), a training technique was developed to train young novice drivers between the age of 17 and 25. The experiment consisted of a pre-training and post-training test in a driving simulator, which confronted the research subjects with nine hazards. In between the pre-training and post-training test there was a period of two weeks, in which the training group received comments from a qualified instructor while driving. Overall, this study had positive results, though a notable disadvantage in this study was the group assignment by the driving instructors. This may cause misinterpretation of the results, since it is very likely that the instructors will assign their less skilled students to the training group (Crundall et al., 2010), which was also reflected in the differences in the number of collisions between the trained and untrained group in the pretest. The authors concluded that their training intervention had a positive effect on the novice drivers' safe driving skills, based on the differences between the pre- and posttest compared to the untrained group. Crundall et al. (2010), however, did not assess the retention effects of their training method. Next to transfer, retention is one of the most important elements for the evaluation of training. It is important to estimate if the effects of training persist over time (Vlakveld, 2011).

The study of Wang et al. (2010), evaluated the hazard handling performances of young novice drivers after a training intervention. The training consisted of three components. The first part was simulated driving, where the participants in the trained group were asked to drive from location A to location B. Along the route they encountered eight risky scenarios of which four were near transfer scenarios and four were far transfer scenarios. For the second part of the intervention, they viewed the playback video of their own driving, filmed from the drivers' view for direct feedback. In the third part of the intervention, the participants viewed a demonstration video showing how an experienced driver might deal with such situations, providing an example of an appropriate response. Wang et al. (2010) found that the trained group performed significantly better than the untrained group in six out of eight critical events for both far and near transfer scenarios, although a larger effect was found for near transfer scenarios. In this study, the hazard detection performances prior to the training were not assessed, nor did it follow up the retention of the increase in performance. Although Wang et al. (2010) examined hazard handling performances of young novice drivers, they mainly focused on collisions resulting from the participants hazard handling skills. Chapman et al. (2002) already acknowledged that checking of mirrors can be of importance and that it would be of interest to develop an intervention that evaluates this. Klauer et al. (2006) recognizes the importance of rear mirror use as a safety-enhancing behavior. It could therefore be interesting to examine mirror use as a component of hazard handling skills.

Fisher (2006) evaluated the trainability of novice drivers to scan for information, making use of an eye-tracking device to record eye movements. The training was a pc-based risk awareness and perception training (RAPT) program which consisted of three RAPT experiments. The program was designed with three principles kept in mind. First, enhancing deep processing in order to increase the likelihood of long-term memory storage. This was done by asking the drivers to visualize for themselves where the risks were located rather than pointing out the risks. Secondly, the aim was to let the drivers recognize risks on the road, even if those never fully resembled the risks seen in training. This was done by means of maximization of near transfer. Cues that are needed to retrieve the knowledge in the situation to which transfer is needed, are directly present in the training. To maximize this type of learning, students were given schematic plan views of the risky scenarios. Lastly, the drivers were learned not only to recognize risks that are similar to the ones that they encounter in the RAPT training, but also other risks they could encounter on the road. Fisher (2006) stated that "RAPT not only presents a scenario which is risky, but also explains to the novice driver why it is risky and what areas of the visual field are obstructed", which is best for learning transfer (Fisher, 2006; Vlakveld, 2011). Fisher (2006) found positive results in the scanning behavior of the trained novice drivers. The RAPT program has been used in other studies as well (Fisher et al., 2007; Pollatsek et al., 2006; Vlakveld, 2011). The three RAPT programs were evaluated in test drives both in a simulator and in real traffic (Fisher, 2006).

One of the most recent studies in the field of hazard perception training was conducted by Vlakveld (2011) and contained three experiments. One of them made use of a simulator-based training method that was created based on the RAPT program, the principals of active learning through errors and the natural way drivers learn to anticipate hazards in real traffic, which motivate further learning about a task (Vlakveld, 2011). This training intervention consisted of three components: [a] a hazard detection drive: in which the possible hazards did not materialize, i.e. the hazards did not occur, [b] an error drive: which was the same as the hazard detection drive, except that this time the hazard did materialize [c] an improvement drive: which was the same as the error drive, but in which hazard manifested itself less aggressively. Each of the training scenarios was trained separately making use of these three steps. The control group received a replacement task, which consisted of a pen and paper training on traffic signs. The effect of this training intervention was assessed in a posttest, in which a distinction was made between far and near transfer scenarios. The study found positive results on gaze directions, especially in near transfer scenarios.

There are different studies that were carried out regarding training hazard perception of novice drivers, making use of different training techniques. Different authors state that the simulator based training methods have some advantages over the other training methods. One advantage is safety (Allen, 2007; Brooks et al., 2010; Kaptein et al., 1996; Riener, 2011), relative to on-road training. Other advantages are allocation of cognitive resources (Vlakveld, 2011) and a wider field of view for detection of cues (Shahar et al., 2010), compared to pc-based training. Training techniques that are based on instructions and comments have shown positive effects in training novice drivers to enhance their hazard perception skills. As depicted in the theoretical framework of Grayson et al. (2003) hazard perception consists of hazard detection, threat appraisal, action selection and implementation. Hazard detection and hazard handling are thus both components of hazard perception. Aforementioned studies mostly focus on training either hazard detection or hazard handling skills and do not evaluate aspects of both components. Moreover, in previous studies, retention of the encountered effects is also rarely investigated.

Present study will take the positive and missing aspects of aforementioned studies into account, to create an instructional and plan view-based training technique.

3.OBJECTIVE AND RESEARCH QUESTIONS

Given the recentness and relevance, the training procedure of the study of Vlakveld (2011) will provide a framework for current study. As cited in Vlakveld (2011), in evaluating training programs, there are two important components: transfer and retention. In ideal conditions, transfer is assessed in an on-road evaluation. Since it is not always possible to assess transfer in on-road situations, the transfer of training could be assessed in a driving simulator. This simulator transfer assessment was also carried out in the study of Vlakveld (2011) and was referred to as 'quasi transfer' assessment. The evaluation of retention is important to estimate if the effects of training persist over time. When there is an effect immediately after training but after a period of time this positive effect is no longer found, retention is low.

In contrast to the training intervention design of the study of Vlakveld (2011), present study will assess the retention of the effects of the training and will conduct a pretest. This will be done to assess the magnitude of the effect of training in a pretest-posttest evaluation, to assess possible initial differences between a trained and a control group and to evaluate the retention of a possible effect in a posttest-retention evaluation. Lastly, a control procedure will be developed whereby participants from the control group can undergo a similar procedure in terms of time spent, followed procedure and simulator scenarios, in which they will still be excluded from any form of hazard perception training. The purpose being to rule out differences in the results due to fatigue or other factors, such as suspicion regarding possible group division.

The main research question of present study is if hazard perception skills (i.e. hazard detection and hazard handling skills) of young novice drivers can be trained, by using a driving simulator. Present study will focus on the glance behavior of the drivers. In order to answer the main question, this study will assess the effects of an instructional training intervention on the eye movements of young novice drivers. The sub questions or associated hypotheses, as stated below, have resulted from the study objective and existing literature on hazard perception and hazard perception training. They provide a framework for the assessment of the trainability. The conducted training will be considered successful when the specified hazard detection and hazard handling performances of the trained young novice drivers improve after training in respect to the control group and do not fall back after a period of two to four weeks (i.e. the effects of training occur in the posttest, as well as in the retention test). The hazard detection and hazard handling performances will furthermore be evaluated separately to see if the training had an effect on both. Based on the information as depicted in previous paragraphs, following hypotheses will be addressed in this study:

- After the training intervention, trained young novice drivers will be more successful in searching for hazards than untrained young novice drivers.
  (This will be assessed with the dependent variables detection time, occurrence of collision and correct hazard detection.)
- After the training intervention, trained young novice drivers will use their rear mirror more accurately than untrained ones.
- After the training intervention, the increased level of hazard detection and hazard handling performance of the trained young novice drivers is larger in near transfer scenarios than in far transfer scenarios.
- An increased level of hazard detection and hazard handling performance of the trained young novice drivers does not fall back two to four weeks after training.

4.METHOD

4.1.Participants

The group of participants consisted of young novice drivers between 17 and 25 years old who either possessed a temporary driver's license and had a minimum of 20 hours driving experience with a driving instructor or 60 hours with another accompanying person (variants, such as 10 hours with a driving instructor and 30 hours with another companion were also permitted), or possessed a permanent driver's license and had a maximum of one year experience in solo driving experience (experience was assessed as: maximum one year after gaining the permanent driver's license).

Although 18 is the age limit for solo driving in Belgium, a temporary driver's license can be obtained from the age of 17. The theoretical and practical training of novice drivers can start at this age and prepares them for solo driving at the age of 18. For this reason, present study will include 17-year-old novice drivers with a minimal driving experience. Crundall et al. (2010) and Underwood (2007) stated that drivers who are within the first year of passing their driving license are at greater risk of being involved in a traffic crash than other drivers. Pradhan et al. (2011) concluded that there is an improvement in hazard perception skills in teenagers after twelve months of driving experience. For this reason, participants with maximum one year of driving experience were allowed to participate. In total, 31 participants were recruited for this study. Two prospective participants with glasses were excluded, as their eye movements could not be calibrated. One participant did not finish the retention test, thus 28 participants remained in the sample and were randomly assigned to the training group and the control group.

TABLE 1 Description of participant data

Group	N	Gender		Age		License					
		Male	Female	Mean	SD	Temporary	Mean	SD	Permanent	Mean	SD
T	15	33%	67%	19.5	1.92	53%	12.1 months	6	47%	5.4 months	3.6
C	14	29%	71%	19.4	1.1	50%	11.8 months	7	50%	11.8 months	2.9

All remaining participants had normal vision or contact lenses and were unaware of the hypotheses or study objectives. After completion of the tests all participants in both training and control group, were offered a voucher of 20 euro for their participation.

4.2.Apparatus

The tests were conducted on a STISIM M400 fixed based driving simulator with a force-feedback steering wheel, an instrumented dashboard, brake and accelerator pedals and with a 135 degree field of view. The visual environment of this simulator is presented on three computer screens (each with 1280 x 800 pixels resolution and 60Hz refresh rate). The eye movements of the participants were recorded while driving through the simulation, making use of a camera-based eye-tracking system (FaceLab^{TM}).

4.3Training material

The training procedure is based on an existing training procedure as it was depicted in the study of Vlakveld (2011). In this study the training procedure was based on the RAPT training program as developed by Fisher (2006) and it was called simRAPT. This training intervention combined the principals of active learning through errors, inducement of arousal to promote memory consolidation, and the natural way drivers learn to anticipate hazards in real traffic (i.e. drivers do not learn when they attribute the cause of the crash to the other road user and need to reflect on their own behavior and think about possible solutions). For the training intervention of present study, instruction slides were created with a plan view of ten hazardous situations and a simulator picture from the driver's perspective (Figure 2, Appendix 1). On the plan view the normal coin of view was depicted, if necessary, divided into visible and invisible areas. The simulator pictures portrayed the focus points of the hazardous situation presented. This was accompanied by instructions of what to look at in these types of situations and what to do to handle the hazards correctly. These instructions were displayed to the participant by means of an enumeration. The plan views were evaluated by a qualified driving instructor who provided these instructions. The instructions were read out to the participants in the same order. All participants from the training group thus receive the same instruction in a likely manner. For the replacement task of the control group, traffic question slides were composed (Appendix 2). The slides contained twenty traffic related questions, two for each of the ten scenarios.

This was to ensure an equal test time of both the training and control group. All the participants from the control group received the same questions in the same order. The answers to these questions were not analyzed.

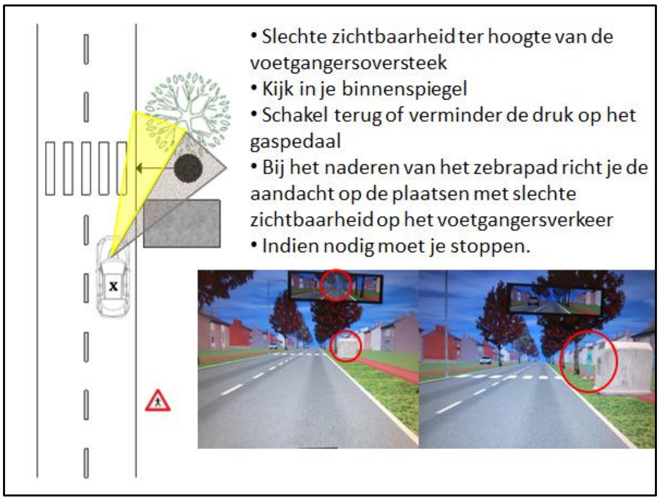

FIGURE 2 Training material - training intervention slide.

4.3.1.Training procedure

Training - first scenario ride In the first ride of the training intervention, the participant drives through a scenario with ten potential hazardous situations, in which the actual hazard does not occur. At the end of this simulated ride the participants are asked to indicate any moments during the ride were they had expected something to happen. This 'prediction of hazards'- question is asked in order to promote self-reflection after a crash or near crash and minimize the tendency to attribute the cause of crashes to other road users or elements (Vlakveld, 2011). No feedback will be provided, regardless of the answer.

Training – second scenario ride The participants drive through the second test ride. They receive the instruction that they will be asked to pull aside during the drive at ten different locations and that they then will receive some explanation of different traffic situations. This second part of the training intervention consists of three components:

- Hazard drive: During the ride whenever the participant has encountered one of the hazards, independent of how it was handled, they are asked to pull aside.
- Training intervention: They will then receive the plan view explanation as described in the training material paragraph. The participant is given a clarification of the elements of the plan view picture and is asked to study the plan view and the simulator picture as the instructions are read out.
- Improvement drive: After the instructions, the participant is asked to proceed in the simulator drive. They will then encounter the same hazard allowing the participant to apply the previously received instructions. This process will be repeated for each of the ten hazards that were selected for training.

Overall the procedure for the control group is similar to that of the training group. The main difference however is that, in the first scenario ride, they will not be asked to indicate any moments during the ride were they had expected something to happen. Furthermore, in the second scenario ride, the control group will not come into contact with the actual hazardous situations when driving through the scenario and they will not receive commentary instructions. Instead, they will receive two traffic related questions for each scenario as was explained in the training material paragraph.

4.4.Test procedure

The simulator tests were spread over two days (Appendix 3). The first testing day consisted of a pre-training test, the training intervention and a post-training test. The second testing day contained a retention test. On the first day at arrival, participants were provided with a consent form to sign and were asked to fill in the Multidimensional Driving Style Inventory (MDSI) questionnaire (Appendix 6). This questionnaire, created by Taubman-Ben-Ari et al. (2004), is a self-report scale that assesses four broad domains of driving style. These broad domains are further subdivided in eight main factors that all represent a specific driving style: dissociative, anxious, risky, angry, high-velocity, distress reduction, patient, and careful. MDSI can be used for the measurement of adaptive and maladaptive driving styles and for the explanation of variations in adaptive and maladaptive driving behaviors (Taubman-Ben-Ari et al., 2004). The questionnaire was given for the purpose of future use and its results will not be discussed in this report. Before starting, basic information and instructions were given to each participant with regard to the experiment and what was expected from them. During these instructions they were advised to drive like they normally do. They would all be driving automatically because of the different experience levels of the participants and to make sure that the most inexperienced drivers did not have to spend most of their attention on shifting gear. After these basic instructions the eye calibration was carried out. Before starting the pretest, the participants first did a familiarization drive of five minutes. Participants then undertook the pre assessment drive throughout a scenario which took ten minutes and in which they encountered ten hazards. After this pre-training drive, 15 participants received the training and 14 participants were randomly assigned to the control group and received the replacement task, which both took approximately one hour of time. After the training intervention, the participant continued in the post-training test, which took circa 18 minutes. In this posttest, they encountered 16 hazardous situations from which 10 were the same as in the pretest. The MDSI questionnaire was provided again on the second test day, before driving through the familiarization drive. The length of the retention test was approximately 40 minutes and the participants encountered 54 hazards. During the pretest, posttest and retention test, there was no one present in the simulator room to ensure their driving behavior would not be affected. At the end of the second day, the participants received their voucher and were thanked for their time and contribution.

4.5.Design and data analysis

The study employed a mixed design. The between-subjects factor was the group to which the participant was randomly assigned (a training group and a control group). The within-subjects factors were the time of assessment (pre-training test versus post-training test and post-training test versus retention test) and transfer (far- and near transfer).

4.5.1.Dependent variables

The dependent variables can be subdivided into hazard detection and hazard handling parameters. The dependent variables of the hazard detection component are [1] detection time, [2] occurrence of collision and [3] correct hazard detection. Since this study's main focus lies on glance behavior, the dependent variable of the hazard handling component will consist of correct rear mirror use [4].

4.5.2.Data analysis

On all dependent measures as depicted above, a separate two-way split-plot Analysis of Variance (ANOVA), was carried out in SPSS in order to analyze the pre-post and post-retention assessment (Field, 2005). This analysis was carried out on *10* hazards that occurred in both pre-, post-, and retention test (Appendix 4). Given the binominal distribution of the variable collision and the small number of crashes that occurred, a Fisher's Exact Test was used on this variable instead of the split-plot ANOVA. For the purpose of analyzing the effect of far and near transfer scenarios a paired sample t-test was carried out, in which the results of the training group in the post- and retention test were analyzed. In case of non-normal distribution, the Wilcoxon signed rank test was used. The *16* hazards that occurred both in the posttest and retention test were subdivided in the categories of far and near transfer (Appendix 4). For analyzing the eye movements of the participants, a video overlay was made in MATHLAB r2007b for each assessment drive. For the detection time [1], the time of the first glance on the hazard was selected. By making use of the programmed onset time of the hazard in the simulator, the detection times were calculated. In order to gather data regarding the dependent variables, the video overlays of each hazard were monitored frame by frame. By doing this, all glances could be analyzed in detail and first glances on the hazard could be identified which led to correct detection times. A collision [2] was defined as a crash with the hazard or an element from the surroundings due to detection failure or failure in the evasive action that was carried out. In order to score correct hazard detection [3], a description of visual search points was made for all the critical events. The participant had to direct her or his eyes towards these points in order to correctly detect the hazard. If more than one glance was required in order to detect the hazard, a score was given to that hazard (i.e. the number of correct glances against the total number of glances required, which was expressed as a percentage). For the analysis of correct mirror use [4], each of the hazards correct rear mirror use was defined based on the driving instructor's comments.

5.RESULTS

5.1.Analysis of detection time

The detection time was defined as the first glance on the hazard. In case of bad eye tracking due to blinking the last documented eye-movement towards the hazard was recorded as the participants detection time. Due to missing values and after deletion of outliers (± 2.5 SDs from the mean), detection times of twenty participants (training: n = 11) remained.

A 2 x 3 split-plot ANOVA compared the mean detection times of the two groups across the three times of testing. The assumptions of normality, sphericity, homogeneity of variance and homogeneity of inter-correlation were met (Appendix 7A). The results revealed a significant interaction effect ($F(2,36) = 4.29$, $p = .021$, $\eta_p^2 = .192$) between group and test time. A post-hoc analysis using a two-way ANOVA (Appendix 7C) confirmed that there was a significant difference in detection times between the trained and untrained group in the posttest ($F(1,25) = 8.17$, $p < .01$, $\eta_p^2 = .246$) and the retention test ($F(1,22) = 5.43$, $p < .05$, $\eta_p^2 = .206$). The results from this analysis also showed that the difference in detection time in the pretest was not significant ($F(1,2) = .02$, $p > .05$, $\eta_p^2 = .001$). As is depicted in Figure 3, the trained group had the greatest reduction in detection time between the pretest and posttest, compared to the control group (30.45% as opposed to 4.39%). In the retention test, the trained group had a further and steeper decline (12.54%), with respect to the control group (7.04%).

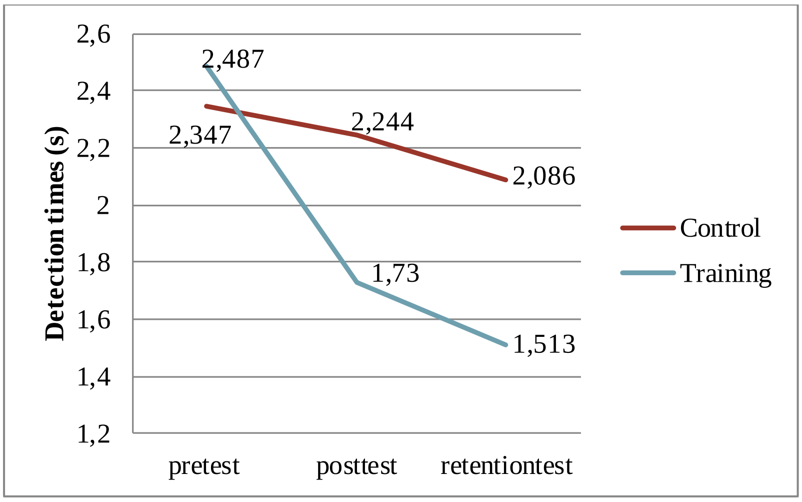

FIGURE 3 The difference in mean detection time between the trained and control group throughout the different periods of testing

The analysis also showed a significant main effect of test time ($F(2,36) = 10.96$, $p < .01$, $\eta_p^2 = .378$). The main effect of group was non-significant ($F(1,18) = 3.77$, $p = .068$, $\eta_p^2 = .173$), although the mean detection time of the control group was higher ($\bar{X} = 2.226$s) than that of the training group ($\bar{X} = 1.91$s).

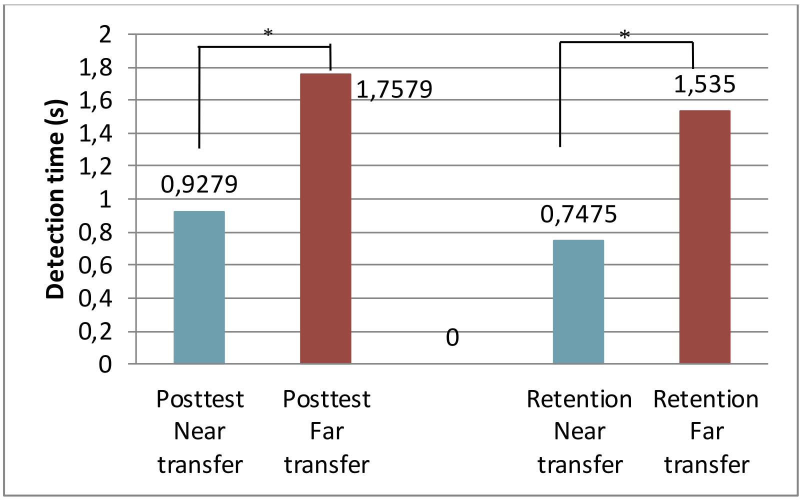

FIGURE 4 Difference in detection times of the trained group between far and near transfer scenarios

A paired sample t-test compared the differences in detection time of the training group between 16 near and far transfer scenarios in the posttest and retention test . The samples had a normal distribution (Appendix 7B). The results showed that in the posttest and retention test there was a significant difference in detection time between the near transfer and far transfer scenarios ($t(13) = -5.93$, $p < .01$) and ($t(11) = -4.01$, $p < .01$), with near transfer scenarios showing lower detection times than far transfer scenarios.

5.2. Analysis of collision

The number of collisions includes incidents where the participant crashed into the hazards or where he/she crashed into other vehicles or surrounding road elements. Crashes that occurred outside the selected hazardous events were not taken up in the analysis. The results of all the participants were considered in the analysis. The collision data was entered in a Fisher's Exact Test (FET) (Appendix 8A). Results from the post assessment showed that two participants from the control group (14.3%) and none of the participants from the training group experienced a crash, a difference that was not statistically significant (p = .224, FET). During the retention test there were no crashes in the control group or the training group. Compared to the pretest, the training group did have a reduction or elimination of crashes during the posttest, whereas the number of crashes in the control group remained constant, yet low.

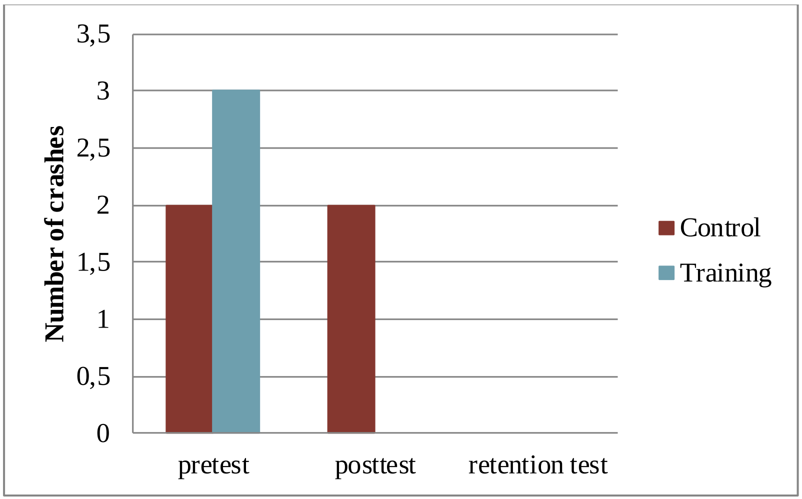

FIGURE 5 The number of crashes of the training and control group across the three testing times

For the far and near transfer analysis of collision, the Wilcoxon signed rank test was used as a substitute for the paired sample t-test (Appendix 8B). The results show that in the posttest, the training intervention did elicit a significant change in the number of collisions between the near transfer and far transfer hazards (Z = -2.45, p = .014). However, the number of collisions was higher in the near transfer hazards than in the far transfer hazards. In the retention test, the training intervention did not elicit a significant change in the number of collisions between the near transfer and far transfer hazards (Z = -1.00, p = .317). The one collision that occurred in the retention test, took place in a near transfer hazard.

5.3. Analysis of correct hazard detection

For the assessment of hazard detection, the visual search points for each hazard were determined (Appendix 4). Due to missing values and after deletion of outliers (±2.5 SDs from the mean), detection times of twenty participants (training: n = 11) remained.

A 2 x 3 split-plot ANOVA compared the hazard detection scores of the two groups across the three times of testing. The assumptions of normality, sphericity, homogeneity of variance and homogeneity of inter-correlation were met (Appendix 9A). The interaction effect between group and test time was not significant (F(2,36) = 2.99, p = .063, η_p^2 = .142). The results did reveal a significant main effect of time (F(2,36) = 7.54, p < .01, η_p^2 = .295) and group (F(1,18) = 8.87, p < .01, η_p^2 = .33). As displayed in Figure 6, the training and control group had approximately equal hazard detection scores in the pretest. In the posttest both groups had an increase in hazard detection scores, although the scores of the trained group were 9% higher than that of the control group. This smaller difference in the posttest could explain the non-significant interaction effect. The positive effect on the scores of the trained group remained and even increased in the retention test, whereas the control group had a decrease in hazard detection scores. In the retention test, the trained group had 18.8% (17.19 percentage points) more accurate hazard detection compared to the pretest. The control group had a total increase of 3.49% (2.69 percentage points).

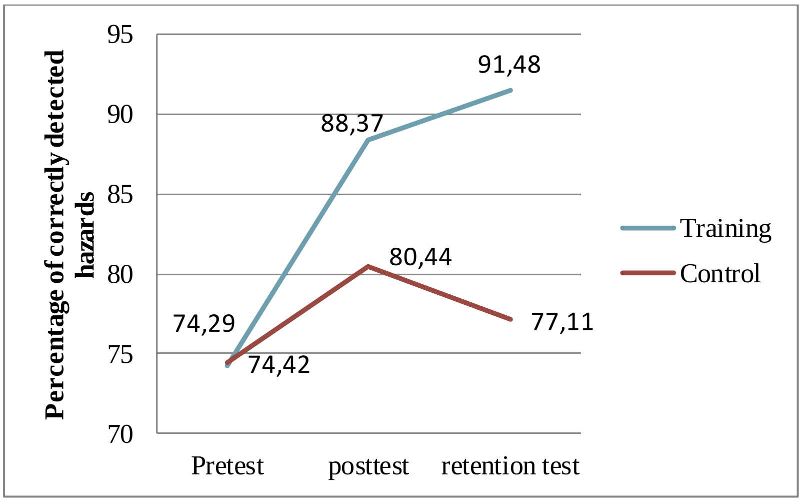

FIGURE 6 Percentage of correct hazard detection of the training and control group across the three testing times

A paired sample t-test compared the hazard detection scores of the training group between near and far transfer scenarios in the posttest and retention test. The samples had a normal distribution (Appendix 9B). The results showed that in the posttest and retention test there was a no significant difference in hazard detection scores between the near transfer and far transfer scenarios ($t(14) = -1.09$, $p > .05$) and ($t(13) = -.06$, $p > .05$). In fact, the hazard detection scores were slightly greater in the far transfer scenarios than in the near transfer scenarios.

5.4.Analysis of mirror use

Correct rear mirror use was predetermined for every hazard (Appendix 4) and was displayed as a percentage. Due to missing values and after deletion of outliers (±2.5 SDs from the mean), 24 participants (training: n = 13) remained. A 2 x 3 split-plot ANOVA compared the mean percentage of rear mirror use of the two groups across the three times of testing. The assumptions of normality, sphericity, homogeneity of variance and homogeneity of inter-correlation were met (Appendix 10A). The results revealed a significant interaction effect ($F(2,42) = 33.69$, $p < .01$, $\eta_p^2 = .62$) between group and test time. A post-hoc analysis using a two-way ANOVA (Appendix 10C), confirmed that there was a significant difference in mirror use between the trained and untrained group in the posttest ($F(1,27) = 35.32$, $p < .01$, $\eta_p^2 = .567$) and the retention test ($F(1,23) = 38.92$, $p < .01$, $\eta_p^2 = .629$). These results also showed that the difference between the training and control group in the pretest was non-significant ($F(1,26) = .98$, $p > .05$, $\eta_p^2 = .036$). As presented in Figure 7, the percentage of mirror use of the trained group strongly increased, whereas that of the control group mildly decreased. There also was a significant main effect for both test time ($F(2,42) = 6.65$, $p < .01$, $\eta_p^2 = .24$) and group ($F(1,21) = 32.6$, $p < .01$, $\eta_p^2 = .608$).

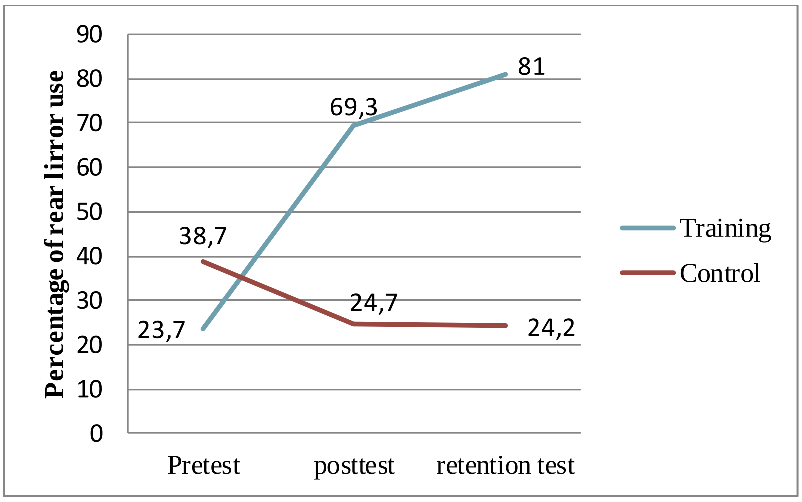

FIGURE 7 Percentage of rear mirror use of the training an control group across the three testing times

A paired sample t-test compared the differences in mirror use of the training group between near and far transfer scenarios in the posttest and retention test. The samples had a normal distribution (Appendix 10B). The results showed that in the posttest and retention test there was no significant difference in mirror use between the near transfer and far transfer scenarios (($t(14) = -.43$, $p > .05$) and ($t(11) = -.96$, $p > .05$)). As in the hazard detection variable, the rear mirror scores were greater in the far transfer scenarios than in the near transfer scenarios.

5.5 Discussion

The training intervention did appear to have a positive effect on the drivers general eye scanning behavior. The trained group had a strong reduction in mean detection time between the pretest and the posttest and a further reduction during the retention assessment. There was a significant interaction effect indicating that the training intervention had a positive effect on reducing the detection time and that the reduction in detection time from pretest to posttest and retention test was greater for the training group than for the control group. In total, the trained group decreased their detection time with 39.2% whereas the control group had a total reduction of 11.12%. The main effect of the group variable was not significant. Still, the total mean detection time of the trained group was 16.5% lower than that of the control group and there was a significant interaction effect. Therefore it can be assumed that a significant result of the main effect might have been found with a larger sample size. The decrease in detection time of the control group could result from the fact that by undergoing the pretest hazards, they also had some expectation of what would happen in the following assessment tests and adapted their usual eye-scanning behavior. In the analysis of near and far transfer on detection time, the results indicated that the trained group clearly performed better in the near transfer than in the far transfer scenarios.

The effects of the training intervention on the number of collisions are inconclusive. Although there was an immediate reduction in the number of crashes in the trained group during the posttest, which remained during the retention test, this reduction was not significantly different from the number of crashes in the untrained group. However, as argued by Klauer et al. (2006), crashes are related to failure in looking towards the right directions or objects at the right time. The effect of present training on the number of collisions should therefore not be discarded. A larger dataset might give more insight in the effect of the current training intervention. In the far and near transfer analysis of collision the results showed that in the posttest, the training intervention did elicit a significant change in number of collisions between the near transfer and far transfer scenarios. However, the number of collisions was higher in the near transfer hazards than in the far transfer hazards. A selection bias in the training intervention hazards could explain these counterintuitive results. The near transfer hazards are the hazards that are conceptually the same as the hazards that were chosen for training. It is possible that the training and near transfer hazards are more aggressive than the far transfer hazards and that therefore the number of collisions is higher in the near transfer scenarios.

The hazard detection analysis results showed that there was a difference in correct hazard detection between the training and control group and the trained group had a very steep increase in the mean percentage of correct hazard detection (18.8%). The control group had an initial but smaller increase during the posttest, but it declined during the retention test. This initial increase of the control group could be due to the fact that the posttest occurred on the same day as the pretest and that due to the recent hazard experiences this group increased their search for hazards as well. However they did not receive any training intervention and when the fresh memory trace of the hazards diminished, the advantage of simple exposure decreased during the retention test. On the contrary, the fact that the training group kept and even increased their gain during the retention test can be explained by neuroplasticity-based learning theories that a good time delay is needed for learning consolidation (Doyon & Benali, 2005). Even though there was no interaction effect between group and time, with the significant main effect of group and the steep increase of the hazard detection scores of the trained group it is assumed that the training intervention had a positive effect on this variable. This relates to the findings of Fisher (2006) who, using a similar training method (RAPT), found that their trained young novice drivers performed better in scanning the road for relevant hazard related information.

A highly significant positive result was found on the rear mirror use of the trained drivers. Their rear mirror use drastically improved from the pretest to the posttest and retention test. Although it has to be taken into account that the trained group performed worse in the pretest, which gives a larger scope within the scale for the trained group to improve compared to the control group, the large difference in the posttest and retention test and the highly significant results do suggest that the training intervention succeeded in increasing the rear mirror use of the trained group and that this positive effect persisted over a two to four-week period of time. A post hoc analysis on the pretest, posttest and retention test supports this reasoning as the difference between the training and control group in the pretest was not significant, but the differences in the posttest and retention test were significant. The decrease in mirror use of the control group could be explained in relation to the decrease in detection time as noted earlier. The control group was not notified about the importance of mirror use, as opposed to the trained group, and might have paid less attention to this by focusing more on searching for hazards. The near and far transfer analysis of both correct hazard detection and rear mirror use were inconclusive.

6.CONCLUSION AND RECOMMENDATIONS

Hazard perception is an important skill for traffic safety (Horswill & McKenna, 2004; Shahar et al., 2010). The ability to predict and detect hazardous situations is more poorly developed in young novice drivers compared to older, more experienced drivers (Borowsky et al., 2010; Chapman & Underwood, 1998; Crundall et al., 2010). An instructional and plan view-based training intervention was developed to improve hazard perception skills. The main goal of this study was to examine whether hazard perception skills of young novice drivers could be trained in a driving simulator by using this training intervention. This was done by comparing the detection time, the occurrence of collision, the correct hazard detection and the rear mirror use between young novice drivers that were randomly assigned to a training and control group, in a pre-, post-, and retention assessment. The rear mirror parameter was used to get a first impression on the trainability of the visual hazard handling skills of the novice drivers. The detection time, the occurrence of collision and the correct hazard detection were evaluated to assess the effect of training on the hazard detection skills.

With respect to the first hypothesis, based on the eye-movements, the trained drivers were more successful in searching for hazards than the untrained drivers although the results of the occurrence of collision were inconclusive. The trained group had a strong reduction in mean detection time and a steep increase in the mean percentage of correct hazard detection. In the posttest and retention test the trained group performed significantly better on detection time and correct hazard detection, compared to the control group.

The highly significant results on the correct rear mirror use, give an insight in the trainability of mirror use in general. The results that were found for this variable support the hypothesis that after the training intervention, the trained young novice drivers use their rear mirror more accurately than the untrained young novice drives. Given the importance of mirror use in hazard perception and general traffic safety (Chapman et al., 2002; Klauer et al., 2006) it could be of interest to incorporate overall mirror use in future hazard perception training studies.

With respect to the third hypothesis, in the analysis of far and near transfers only the variable detection time gave a positive and conclusive result. In retrospect, it can be argued that due to a selection bias, the types of hazards that were selected for the purpose of training had an effect on the results of far and near transfer analysis of mirror use and correct hazard detection. In the results of the variable 'number of collision', the significantly higher number of crashes in the near transfer scenarios could also be attributed to the type and aggressiveness of the near transfer hazards. As described by Crundall et al. (2012), participants can react differently towards different types of hazards. In their study they made a clear distinction between Behavioral Prediction, Environmental Prediction and Dividing and Focusing attention hazards (Crundall et al., 2010) and the fixations differences between those types. In the study of Vlakveld (2011) another distinction was made between latent overt-, latent covert- and imminent hazards. These differences in hazard types could be further examined and used as a basis for selecting training hazards.

Looking at the retention effect of the variables that showed a positive effect (i.e. detection time, correct hazard detection and rear mirror use), the trained group did not have a fallback during the retention assessment and there even was a further improvement during this retention test. This indicates that the positive results of the training intervention persist over a two to four week period of time. These results are in support of the forth hypothesis in which was stated that the increased level of performance does not fall back two to four weeks after training.

Present study gave some indication of the trainability of hazard perception skills. Nevertheless, it is of interest for further research to expand the sample size and conduct an on-road experiment to validate the results that were found. As noted before, near and far transfer should also be assessed in on-road driving to make statements about the transferability of the training intervention. With regard to the testing times of the current study, it is suggested by Fisher et al. (2002) that it should be examined if the effect of training persist for six months, since this is the critical window of vulnerability. If time permits, the retention assessment could therefore be carried out six months after training to get a full grasp on the retention effects. Given the positive result of the current training interventions and the training interventions that were carried out by others (Crundall et al., 2010; Fisher, 2006; Vlakveld, 2011), future research may also consider examining the trainability and testability of hazard perception in the context of the Belgian driving education system.

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APPENDICES

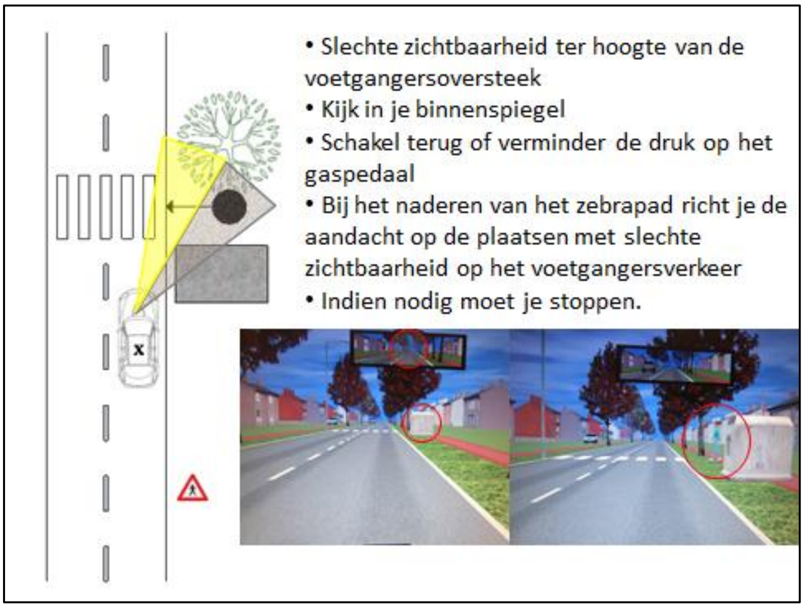
APPENDIX 1: Training intervention material

With the first training slide that was presented to the participant, following verbal explanation was given:

"Dit is een bovenaanzicht van de situatie waar je net bent doorgereden. Deze driehoek geeft je gezichtsveld weer. Het grijze gedeelte geeft het gebied weer dat voor jou niet zichtbaar is. Het gele gedeelte geeft het gebied weer dat voor jou wel zichtbaar is.
Ik ga je nu uitleg geven over deze situatie. Deze punten geven de samenvatting weer van wat ik ga vertellen. Tijdens mijn uitleg bekijk je het overzicht en de aandachtspunten."

1- <u>Training hazard T1</u>

The driver is approaching a zebra crossing. A pedestrian, that is badly visible due to a glass container, crosses the road.



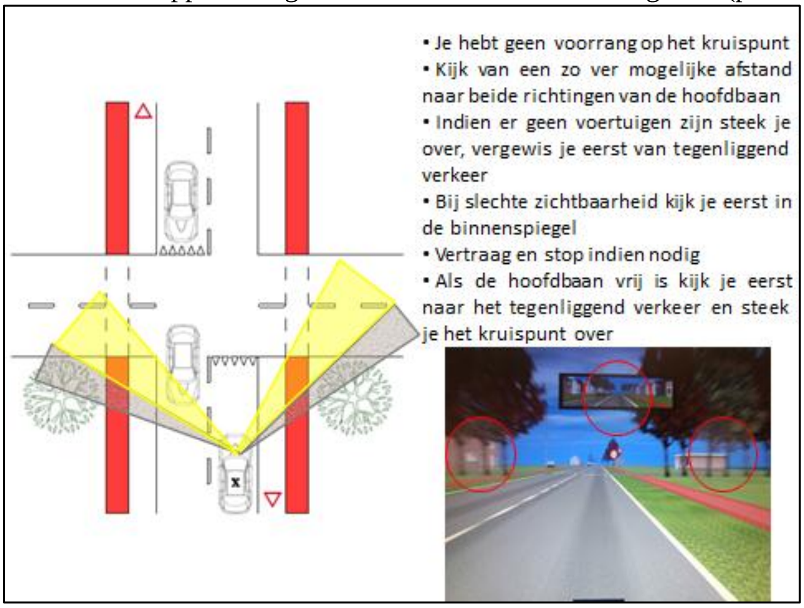
Instruction

Dutch: Het verkeersbord dat je tegenkomt geeft aan dat er zich in de verte een voetgangersoversteek bevindt. Door de slechte zichtbaarheid ter hoogte van het zebrapad moet je je snelheid verlagen. Dit doe je door je eerst te vergewissen van het achterliggend verkeer door in je binnenspiegel te kijken, daarna verminder je de druk op het gaspedaal. Bij het naderen van het zebrapad richt je je aandacht op de plaatsen met slechte zichtbaarheid op het voetgangersverkeer, ook werp je een blik op de andere zijde van de voetgangersoversteek. Indien nodig moet je stoppen.

English: The traffic sign notifies you that there is a pedestrian crossing further down the road. Because of the bad visibility at that location you have to decrease your speed. You do this by checking your rear mirror and then shift back or release pressure from the gas pedal. When nearing the zebra crossing, you have to pay attention to the areas with bad visibility on pedestrians. If necessary you have to stop.

2- <u>Training hazard T2</u>

The driver is approaching an intersection with traffic sign B1 (prioritize and stop if necessary).



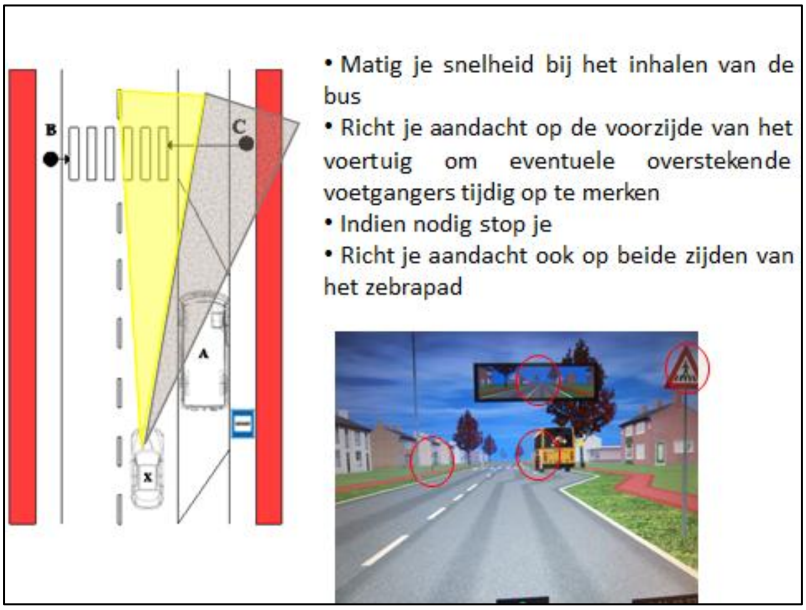
Instruction

Dutch: Het verkeersbord dat je tegen komt geeft aan dat je geen voorrang geniet op het kruispunt. Bij het naderen van een kruispunt moet je van een zo ver mogelijke afstand in beide richtingen kijken of er zich voertuigen op de hoofdbaan bevinden. Als er zich geen voertuigen op de hoofdbaan bevinden mag je het kruispunt oversteken na je te vergewissen van het tegenliggend verkeer. Als de zichtbaarheid op de hoofdbaan beperkt is moet je je vergewissen van het achterliggend verkeer, vertragen en indien nodig stoppen. Als de hoofdbaan vrij is kijk je eerst naar het tegenliggend verkeer en kan je daarna het kruispunt oversteken.

English: The traffic sign warns you that you do not have priority on this intersection. When approaching an intersection, always look in advance for traffic in both directions on the main road. If there are no vehicles on the main road you can cross the intersection after looking at the oncoming traffic. If the visibility of the main road is limited, you have to check your rear mirror, slow down and stop if necessary. If the main road is safe to cross you can ross the intersection after looking at the oncoming traffic.

3- Training hazard T3

Two children suddenly cross the road from behind a parked bus. There is a zebra-crossing present, five meters further down the road.



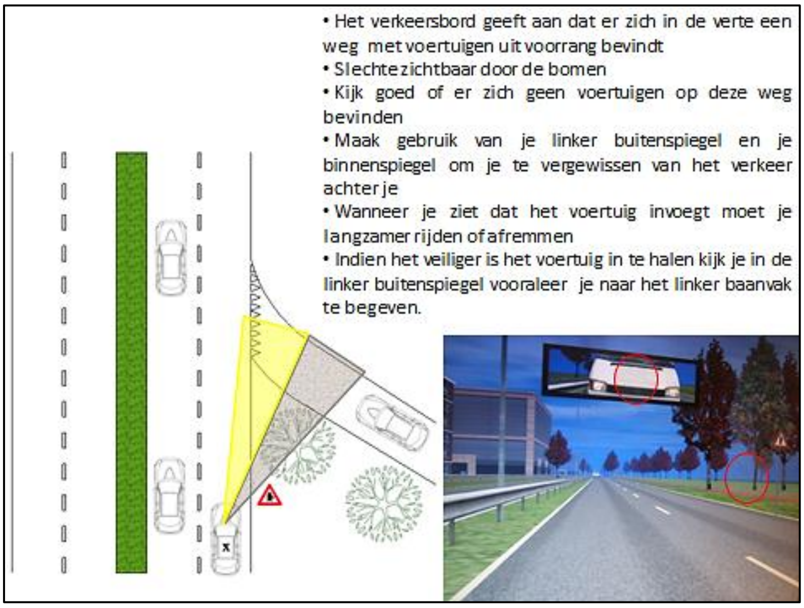
Instruction

Dutch: Het verkeersbord dat je tegen komt geeft aan dat er zich in de verte, na de bushalte, een voetgangersoversteek bevindt. Bij het inhalen van de bus moet je je snelheid matigen en de aandacht richten op de voorzijde van het voertuig om eventuele overstekende voetgangers tijdig op te merken en indien nodig te stoppen. Werp ook een blik in de binnenspiegel om je te vergewissen van het verkeer dat achter je rijdt. Je moet ook de aandacht richten op beide zijden van het zebrapad om ook hier voetgangers die aanstalten maken om over te steken, tijdig op te merken en indien nodig te stoppen.

English: The first traffic sign that you encounter indicates that there is a pedestrian crossing further down the road, after the bus stop. While overtaking the bus you have to drive at a moderate speed and you have to pay attention to the front side of the vehicle to notice possible crossing pedestrians in time. Take a look in the rear mirror to look at the traffic that is driving behind your vehicle. After passing, look at both sides of the zebra crossing to detect possible pedestrians that are preparing to cross and stop if necessary.

4- <u>Training hazard T4</u>

The driver is driving on a priority road. Another car, coming from the right, inserts onto the priority road.



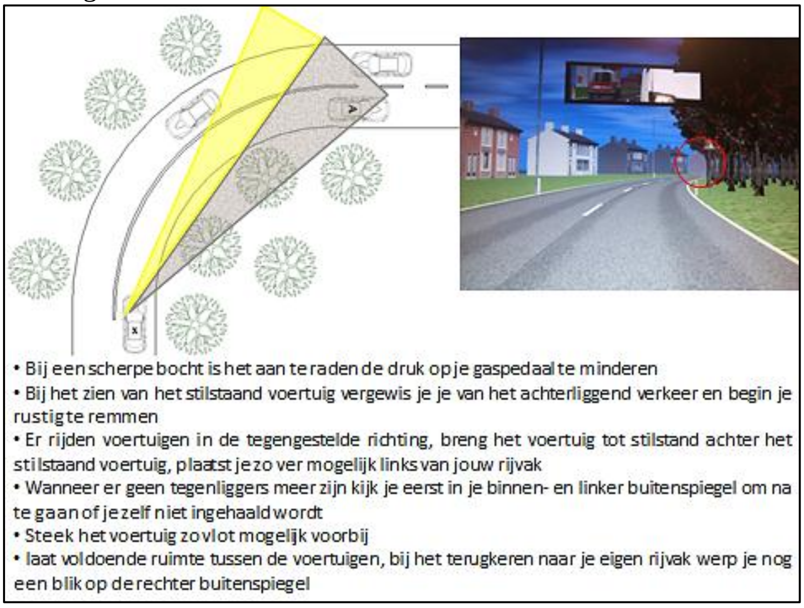
Instruction

Dutch: Het verkeersbord dat je tegen komt geeft aan dat je op een hoofdbaan rijdt en dat er zich in de verte een weg met voertuigen uit voorrang bevindt. Deze weg is niet goed zichtbaar door de bomen en je moet goed kijken of er zich geen voertuigen op deze weg bevinden. Het is relatief druk op de hoofdbaan, je moet gebruik maken van je linker buitenspiegel en je binnenspiegel om je te vergewissen van het verkeer dat achter je rijdt. Wanneer je ziet dat het voertuig zich op de hoofdbaan invoegt moet je langzamer rijden of afremmen. Indien het, omwille van het achterliggend verkeer, veiliger is het voertuig in te halen moet je in de linker buitenspiegel kijken om zeker te zijn dat er niemand jou inhaalt vooraleer je naar het linker baanvak te gaan. Wanneer je dan terug keert naar het rechter baanvak, werp je nog een blik op de rechter buitenspiegel.

English: The traffic sign notifies you that you are driving on a priority road and that further down the road, there is a road with vehicles without priority. This road is badly visible due to the trees. You have to look carefully to see if there are vehicles on this road. The main road that you are driving on is busy so you have to make use of your rear- and left mirror to look at the traffic behind you. When you see the vehicle inserting onto the main road, you have to slow down or break. If it is safer, due to traffic behind you, to overtake the vehicle you have to check your left mirror to make sure nobody is overtaking you before you go to the left lane.

5- <u>Training hazard T5</u>

The driver is approaching a Sharp curve with bad visibility. Immediately after the curve, a car is standing still.



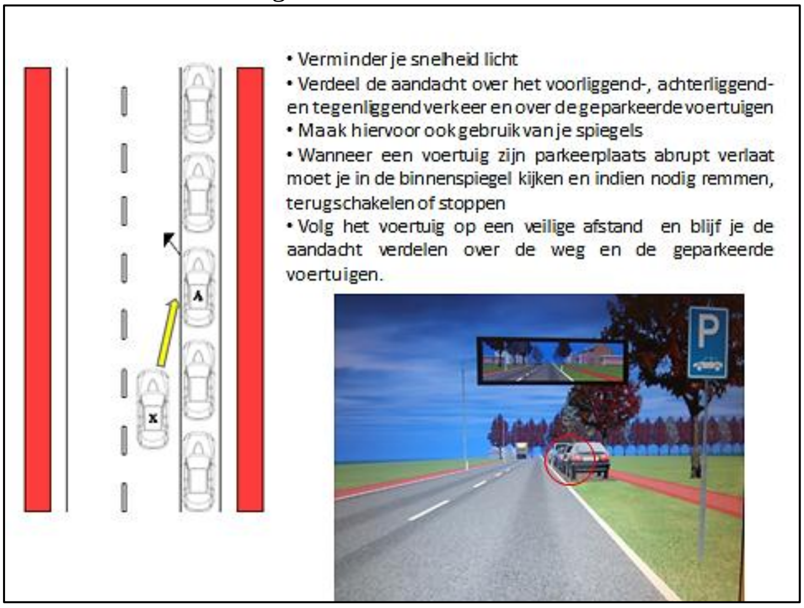
Instruction

Dutch: Wanneer je een scherpe bocht moet nemen, is het aan te raden de druk op je gaspedaal te minderen. Bij het zien van het stilstaand voertuig moet je je eerst vergewissen van het achterliggend verkeer en dan rustig beginnen te remmen. Omdat er zich voertuigen in de tegengestelde richting bevinden kan je het voertuig niet direct inhalen. Je brengt het voertuig tot stilstand achter het stilstaand voertuig en plaatst je zo ver mogelijk links van jouw rijvak om zo beter zicht te hebben op het aankomend verkeer. Wanneer er geen tegenliggers meer zijn kijk je eerst in je binnen- en linker buitenspiegel om na te gaan of je zelf niet ingehaald wordt. Wanneer het veilig is om in te halen steek je het voertuig zo vlot mogelijk voorbij. Hierbij laat je voldoende ruimte tussen de voertuigen en controleer je de omgeving rond het voertuig om eventuele passagiers tijd op te merken. Bij het terugkeren naar je eigen rijvak werp je nog een blik op de rechter buitenspiegel.

English: When you have to take a sharp curve, it is advisable to release pressure from the gas pedal. When you see the stationary vehicle, you first have to check your rear mirror and then start to break calmly. Because there are vehicles in the opposite direction, you cannot overtake immediately. You bring the vehicle to a halt and you position yourself to the left of your lane to have a better view on oncoming traffic. When there is no more oncoming traffic, you check your rear- and left mirror to make sure nobody is overtaking you, and then you overtake the vehicle as smoothly as possible. Doing this you must leave enough space between the vehicles. When returning to your lane, glance at your right mirror.

6- <u>Training hazard T6</u>

The driver is driving on a road with parked cars on his right. A car abruptly pulls out from the parked vehicles without making use of his direction indicator.



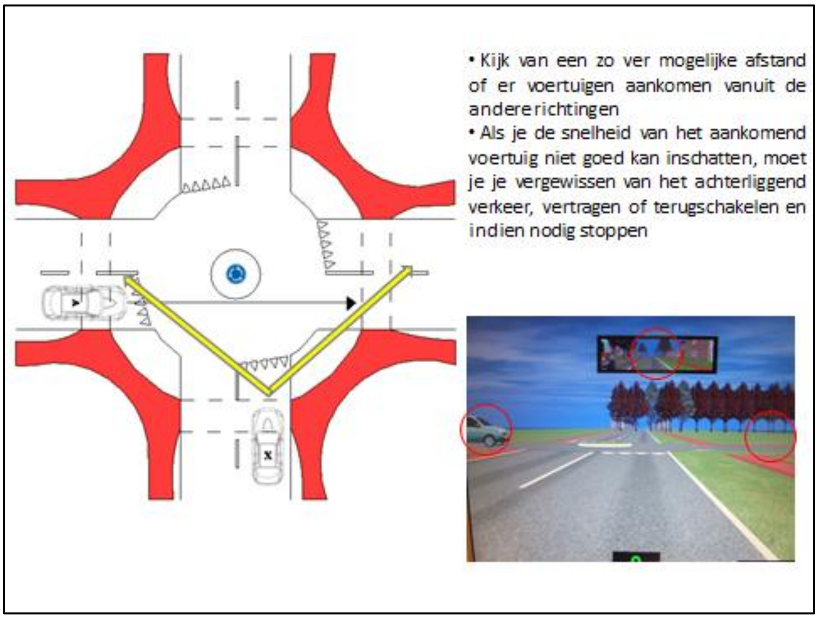
Instruction

Dutch: Wanneer je je in deze situatie bevindt moet je je snelheid licht verminderen. Je moet de aandacht verdelen over het voorliggend-, achterliggend- en tegenliggend verkeer en over de geparkeerde voertuigen. Maak hiervoor ook gebruik van je binnenspiegel. Wanneer een voertuig zijn parkeerplaats abrupt verlaat moet je in de binnenspiegel kijken en indien nodig remmen of stoppen. Daarna volg je het voertuig op een veilige afstand en blijf je de aandacht verdelen over de weg en de overige geparkeerde voertuigen.

English: When you are driving in this situation, you have to mildly decrease your speed. You have to divide your attention between the vehicles in front of you and behind you, the oncoming traffic and the parked vehicles. Make use of your mirrors to do so. When a vehicle abruptly leaves his parking space, you have to check your rear mirror and break, shift back or stop if necessary. Afterwards you follow on a safe distance and keep dividing your attention between the road and the parked vehicles.

7- <u>Training hazard T7</u>

The driver is driving towards a roundabout. There is a car coming from the left and it takes the second exit.

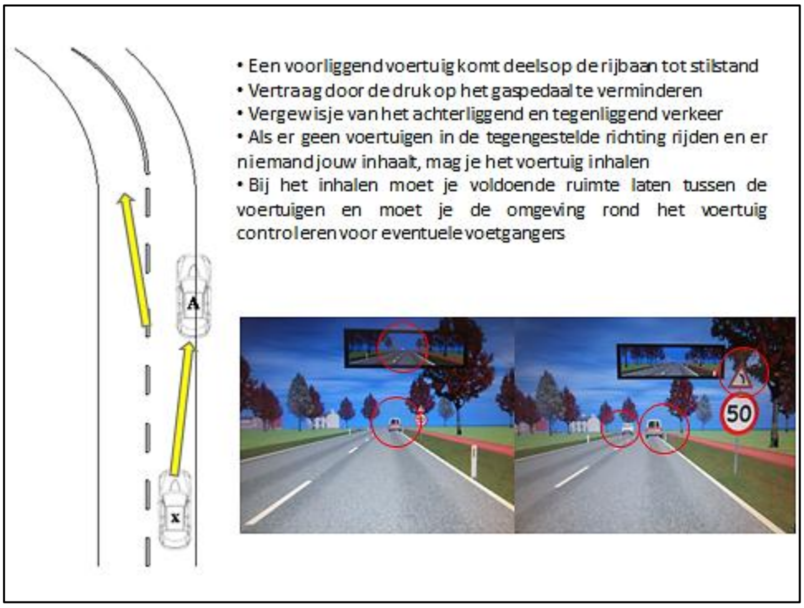


Instruction

Dutch: Bij het naderen van een rondpunt moet je van een zo ver mogelijke afstand kijken of er voertuigen aankomen vanuit de andere richtingen. Als je de snelheid van het aankomend voertuig niet goed kan schatten of je hebt een beperkt zicht, moet je je vergewissen van het achterliggend verkeer, vertragen en indien nodig stoppen.

English: When approaching a roundabout, you have to look in advance if there are vehicles approaching from the other directions. If you cannot estimate the speed of the approaching vehicle, you have to look in your rear mirror, slow down or shift back and stop if necessary.

8- Training hazard T8



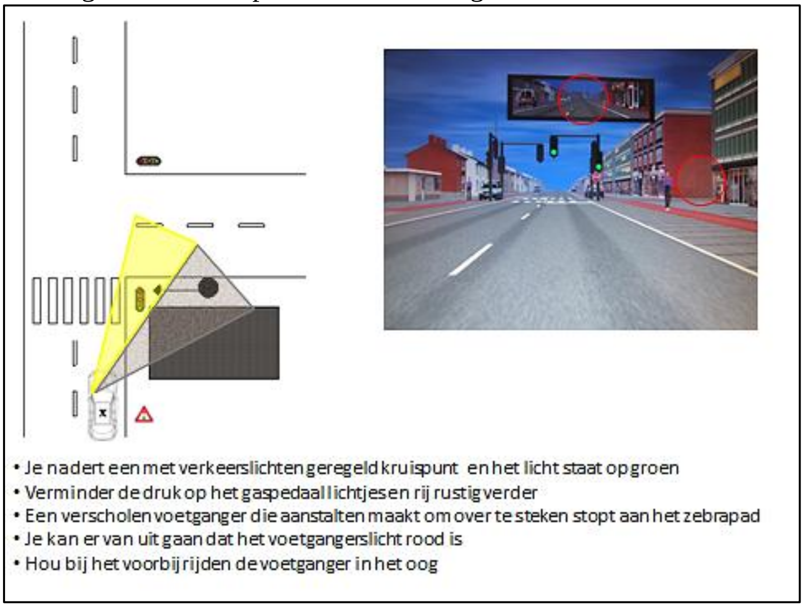
Instruction

Dutch: Wanneer je ziet dat een voorliggend voertuig in de verte, deels op de rijbaan, tot stilstand komt moet je vertragen door de druk op het gaspedaal te verminderen. Door dit te doen ben je tijd winnen om je te vergewissen van het achterliggend en tegenliggend verkeer. Als er geen voertuigen in de tegengestelde richting rijden kijk je in je linker buitenspiegel en binnenspiegel en mag je het voertuig inhalen. Bij het inhalen moet je voldoende ruimte laten tussen de voertuigen en moet je de omgeving rond het voertuig controleren om eventuele voetgangers of passagiers tijdig op te merken. Wanneer je terug naar het rechter baanvak gaat, werp je nog een blik in de rechter buitenspiegel.

English: When you see that a vehicle has is pulling aside partly on the road in the distance, you have to slow down by releasing pressure from the gas pedal. By doing this you can win time to check the rear mirror for traffic and check the oncoming traffic. If there is no oncoming traffic and nobody is overtaking you, you can overtake the vehicle. While overtaking you have to leave enough space between the vehicles and you have to pay attention to the area around the vehicle to notice possible pedestrians.

9- <u>Training hazard T9</u>

A pedestrian is approaching from the right side of the T intersection and she stops in front of the zebra crossing due to a red pedestrian traffic light.



Instruction

Dutch: Wanneer je een met verkeerslichten geregeld kruispunt nadert en het licht staat op groen kijk je in de binnenspiegel om je te vergewissen van het verkeer dat achter je rijdt, verminder je de druk op het gaspedaal lichtjes, maar rij je rustig verder. Een voetganger die aanstalten maakt om over te steken stopt aan het zebrapad. Je kunt er van uit gaan dat het voetgangerslicht rood is. Hou bij het voorbij rijden de voetganger in het oog.

English: When you approach an intersection with traffic lights and the light is turned green, you have to check your rear mirror for traffic and release some pressure from the gas pedal. A pedestrian that prepares to cross, stops at the zebra crossing. You can assume that the light for the pedestrian is turned red. Keep an eye on the pedestrian while passing.

10- <u>Training hazard T10</u>

Two pedestrians are going to cross the road. The first one stops at the side of the road. The second one with dog is crosses the road by making use of the pedestrian crossing.

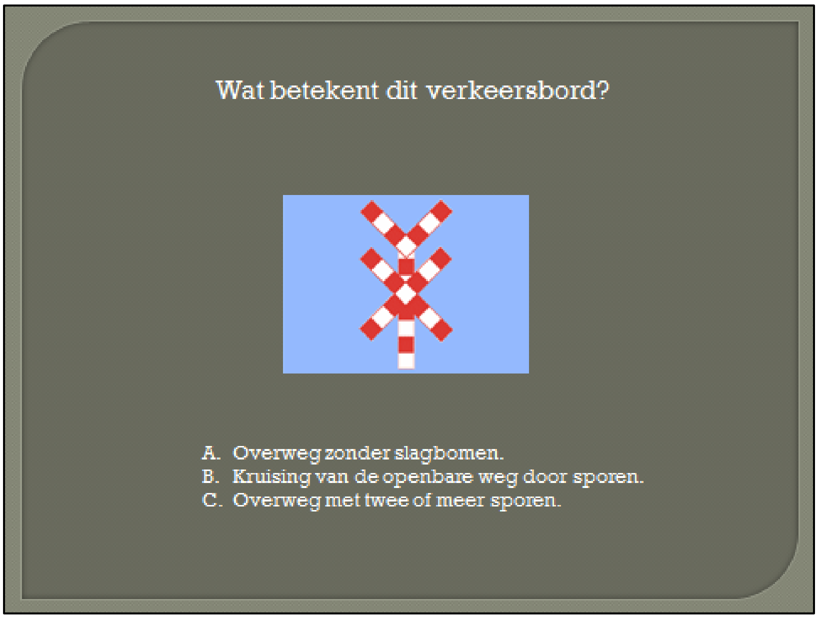
Instruction

Dutch: Het verkeersbord geeft aan dat er zich in de verte een voetgangersoversteek bevindt. Bij het naderen van een voetgangersoversteek moet de omgeving gecontroleerd worden om voetgangers die aanstalten maken om over te steken tijdig op te merken. Wanneer je een voetganger opmerkt moet je de druk op het gaspedaal verminderen. Je moet je vergewissen van achterliggend en tegenliggend verkeer indien het noodzakelijk is om te stoppen of uit te wijken. Na je te vergewissen van achterliggend verkeer ben je verplicht om voor de tweede voetganger te stoppen.

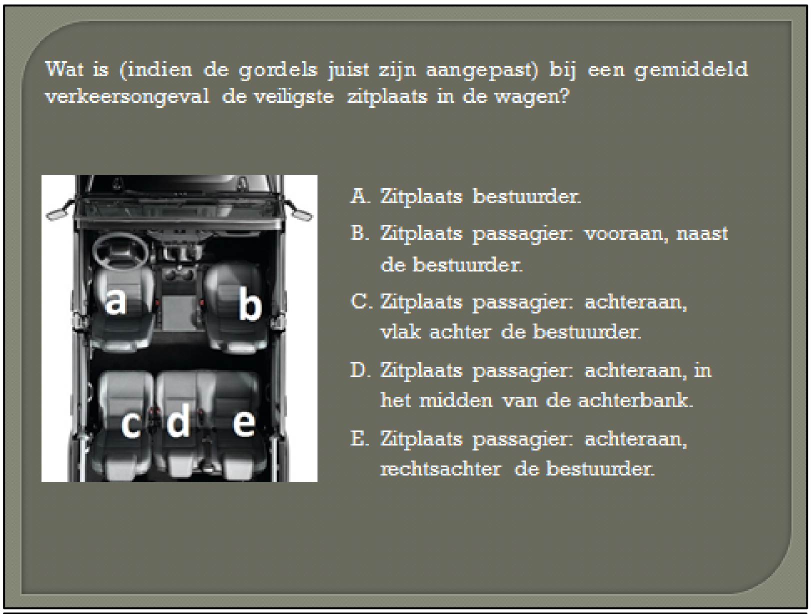
English: The traffic sign indicates that further down the road there is a pedestrian crossing. When nearing the pedestrian crossing, you have to check the environment to note pedestrians that are preparing to cross the road. When you notice a pedestrian, you have to release some pressure from the gas pedal. You have to check your rear mirror and the oncoming traffic in case you have to stop or swerve. After checking for traffic in your rear mirror, you are obligated to stop and let the second pedestrian cross.

APPENDIX 2: Control intervention material

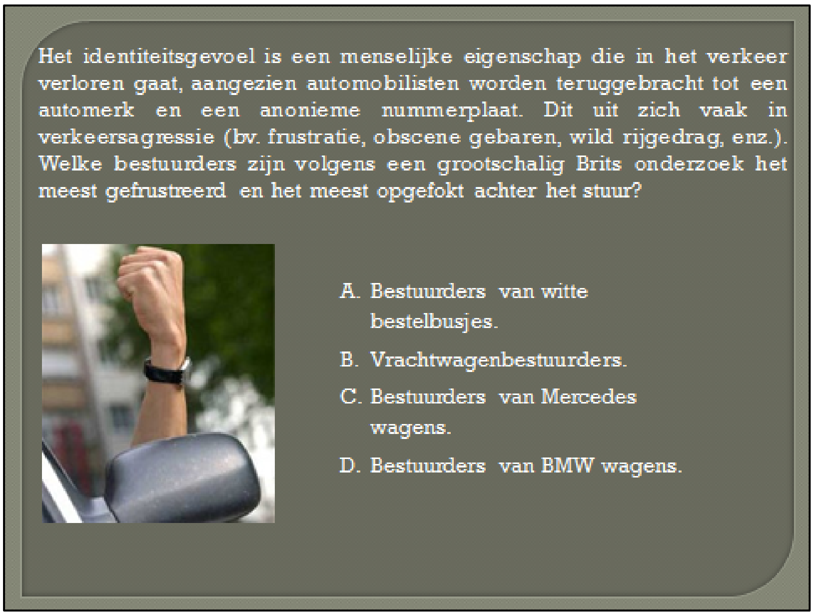
1- Control hazard C1



2- Control hazard C2

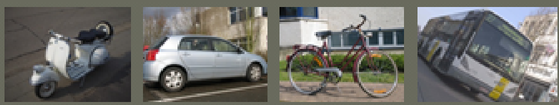


3- <u>Control hazard C3</u>



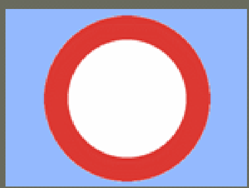
4- Control hazard C4

Als we nagaan hoe groot de kans is om te sterven of om zwaargewond te geraken per afgelegde kilometer, hoe veilig zijn dan de verschillende transportmodi die hieronder afgebeeld worden? Als je deze 4 transportmodi in een rijtje moet zetten, met vooraan in de rij het transportmiddel dat het veiligst is (per afgelegde kilometer) en achteraan in de rij het transportmiddel dat het onveiligst is (per afgelegde kilometer), hoe ziet die rij er dan uit?



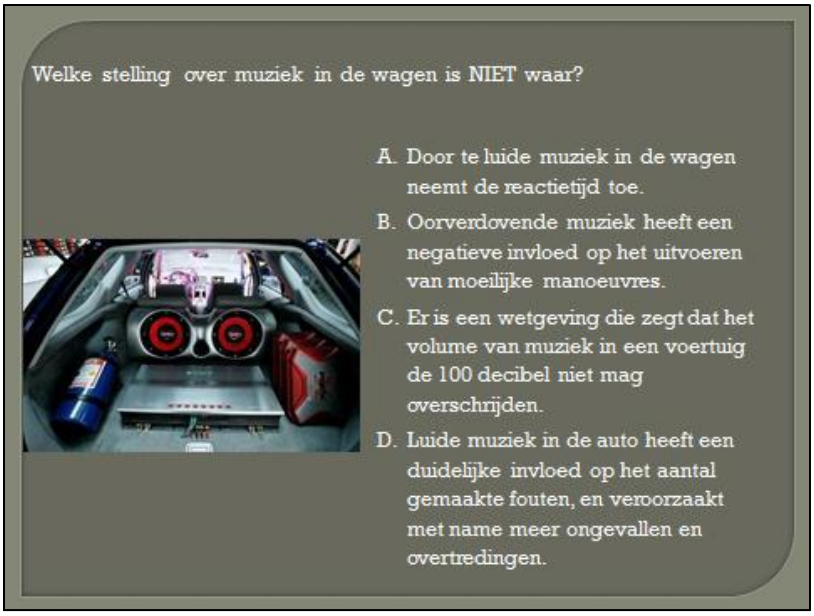
A. Wagen – Bus – Brommer – Fiets
B. Bus – Fiets – Wagen – Brommer
C. Wagen – Bus – Fiets – Brommer
D. Bus – Wagen – Fiets – Brommer

Wat betekent dit verkeersbord?

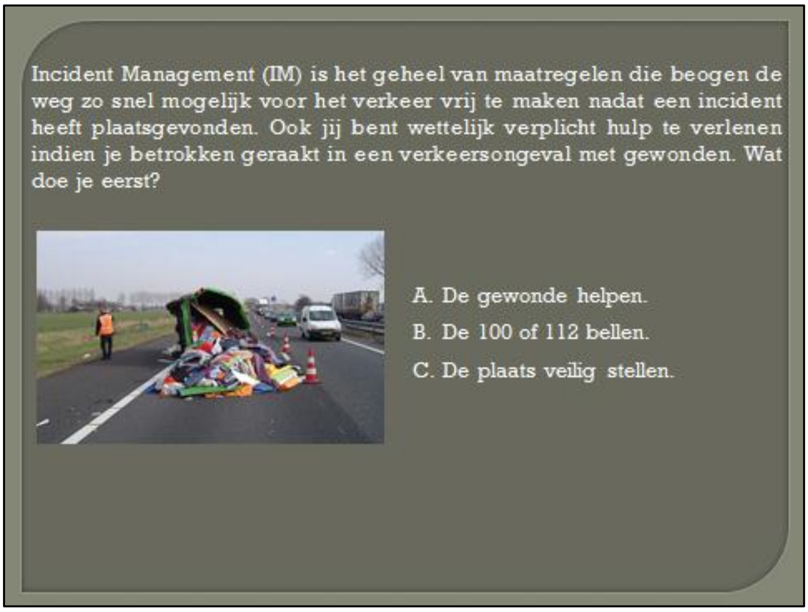


A. Verboden toegang voor iedere bestuurder in beide richtingen.
B. Verboden richting voor iedere bestuurder.
C. Verboden richting voor iedere weggebruiker.

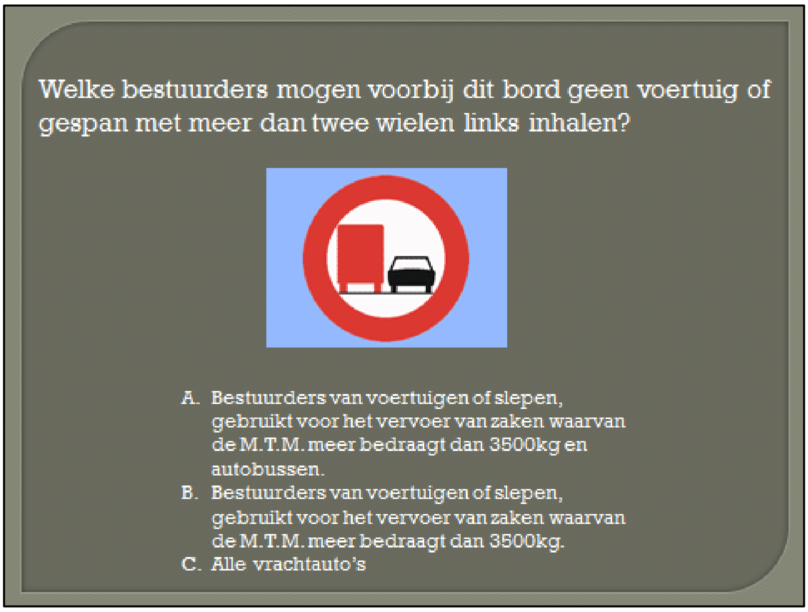
5- Control hazard C5



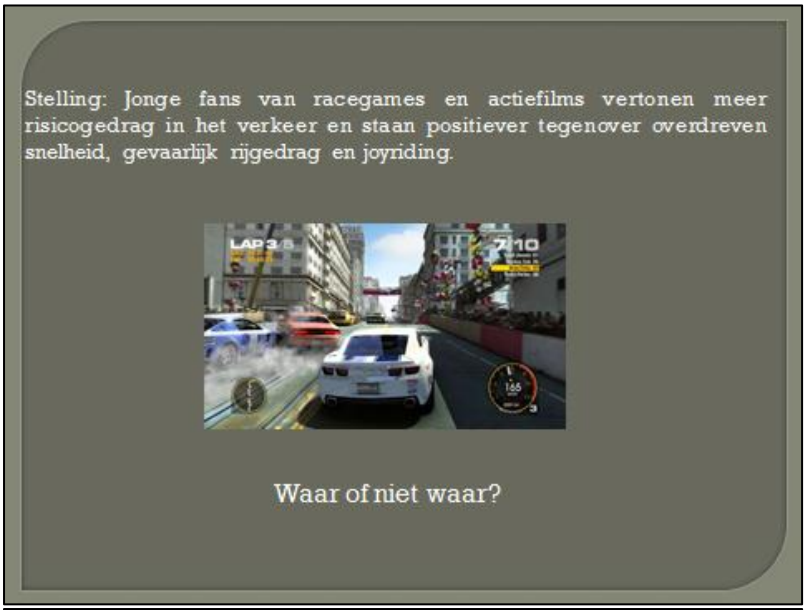
6- <u>Control hazard C6</u>



7- <u>Control hazard C7</u>



8- Control hazard C8

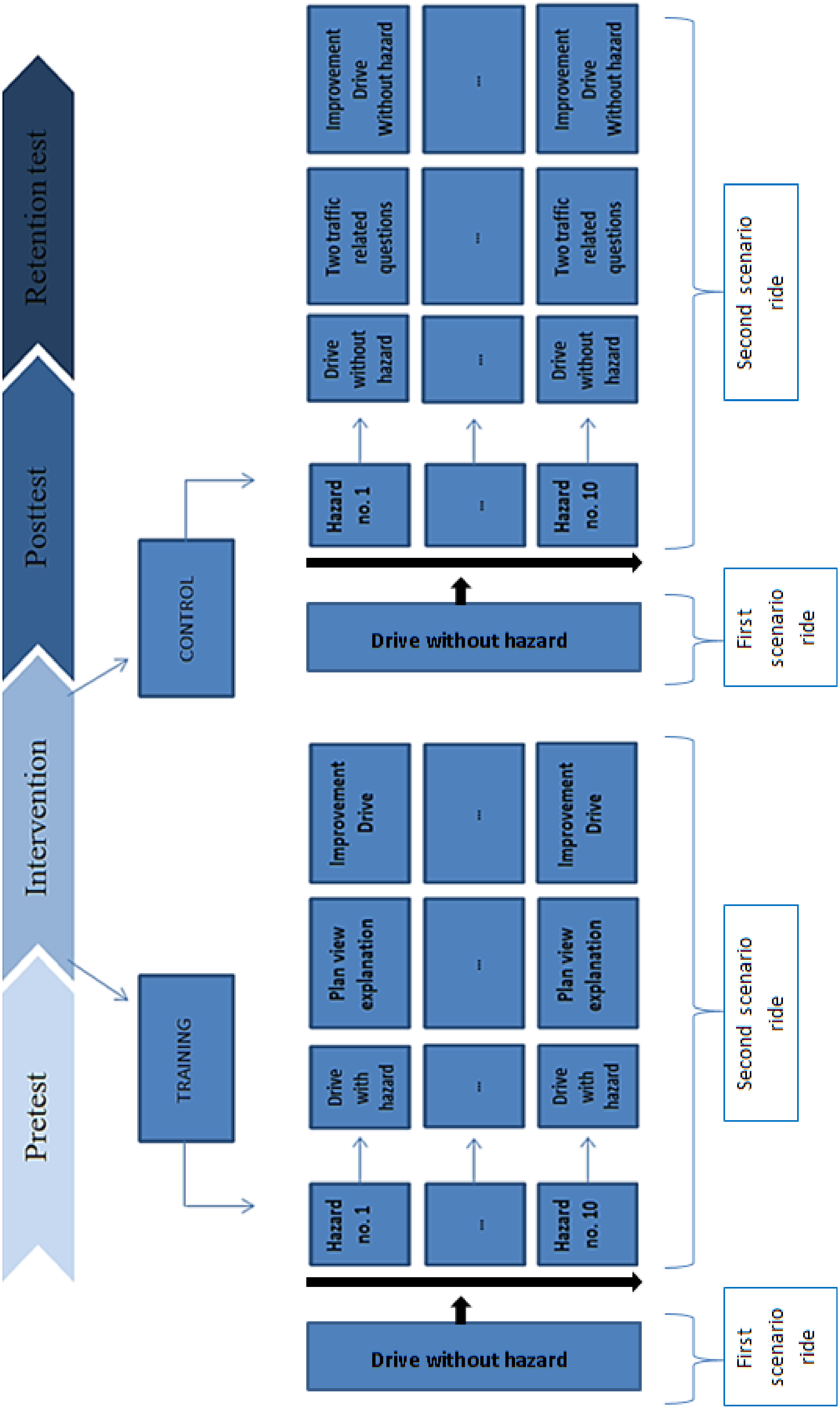


9- Control hazard C9

10- <u>Control hazard C10</u>

APPENDIX 3: Schematic overview of the procedure

Schematic overview of the training procedure – section 4.3.1



APPENDIX 4: Hazard overview table

Following table provides an overview and description of all the hazards that were analyzed. Furthermore, the critical visual search points that are requested to correctly detect a hazard are displayed. The visual search point that was used for the analysis of detection time is marked in italic. The table also shows in which test each hazard occurred and whether it is a far or near transfer hazard.

Hazard number	Hazard description	Critical visual search	Pre test	training	Post test	Retention test	Far/Near transfer
1	After 3 bends, there is a T-junction where a car approaches from the right side of the intersection. That car will impact the cyclist that is driving on the right side of the road.	Hazard detection -Glance at traffic sign priority road -Glance at the cyclist -*Glance at the approaching vehicle* Mirror use -Glance at rear mirror (before braking after detection of vehicle or glance at bicycle)	X		X	X	F
2	Two kids are going to cross the road from the left to the right. They will be temporally hidden by trees. The event takes place within a school zone (announced by a school sign 100m early). There is a zebra crossing without traffic lights.	Hazard detection -Glance at traffic sign (30/children zone) -Glance at tree zone at the zebra crossing (search for hidden pedestrians) -*Glance at children crossing* Mirror use -Glance at rear mirror (after detection before braking)	X		X	X	N

Hazard number	Hazard description	Critical visual search	Pre test	training	Post test	Retention test	Far/Near transfer
3	A yellow car is pulling out from the right in front of the driver, without using indicators. (±50 meters away from the driver)	Hazard detection *-Glance at yellow vehicle* Mirror use -Glance at rear mirror (before braking, after glance on either the vehicle or the build-up area sign)	X		X	X	F
4	A car has stopped in the opposite lane because of a crossing child (from left to right). The child is followed by a dog. There is no pedestrian crossing.	Hazard detection -Glance on parked vehicle -Glance on child and dog on the left side of the road, while approaching *-Glance on child and dog while they cross* Mirror use -Glance on rear mirror (after first glance on child and dog, before braking)	X		X	X	F

Hazard number	**Hazard description**	**Critical visual search**	**Pre test**	**training**	**Post test**	**Retention test**	**Far/Near transfer**
5	A pedestrian wants to cross the road from right to left through the zebra crossing (without traffic lights). She steps into the driver's path and crosses.	Hazard detection -Glance at the pedestrian on the side of the road *-Glance at the pedestrian when crossing* Mirror use -Glance on the rear mirror (after first detection, before braking)	X		X	X	N
6	An ambulance (with sirens) emerges from the left which slows down the leading vehicle in front of the driver. (Depending on drivers speed. If the participant is to slow they will only see the ambulance)	Hazard detection -Glance at rear mirror for scanning *-Glance at ambulance* -(if necessary) glance at leading vehicle Mirror use -Glance at rear mirror after detection of ambulance	X		X	X	F

Hazard number	Hazard description	Critical visual search	Pre test	training	Post test	Retention test	Far/Near transfer
7	Small curvy roads, an approaching lorry comes from a small blind bend. It will pull out to avoid crashing on a pedestrian and occupies the driver's lane.	Hazard detection -Glance at pedestrian on the road -Glance on the blind curve where truck appears *-Second glance on the truck at the moment when the truck starts overtaking the pedestrian* Mirror use -Glance at rear mirror (after detection)	X		X	X	F
8	There is a parked trash lorry and a worker is going to load the trash bin which stands on the midline of the road.	Hazard detection -Glance at the trash bin -Glance at the front of the lorry *-Glance at worker* Mirror use -Glance at rear mirror before braking (after detection of the trash lorry before braking)	X		X	X	F

Hazard number	Hazard description	Critical visual search	Pre test	training	Post test	Retention test	Far/Near transfer
9	A pedestrian is approaching from the right side of the T intersection and she stops in front of the zebra crossing because of a red light.	<u>Hazard detection</u> -*Glance at pedestrian* -Second glance at pedestrian when passing <u>Mirror use</u> -Glance at rear mirror (when approaching traffic light, before braking)	X	X	X	X	N
10	Two kids suddenly step onto the road from behind a parked bus while there is a zebra-crossing 5 meter away from to the bus stop.	<u>Hazard detection</u> -Glance at traffic sign pedestrian crossing -Glance at the front of the bus while passing -Glance at children on the other side of the zebra crossing -*glance at crossing children* <u>Mirror use</u> -Glance at rear mirror after glance on traffic sign or after glance at children, before braking	X	X	X	X	N

Hazard number	Hazard description	Critical visual search	Pre test	training	Post test	Retention test	Far/Near transfer
11	2 pedestrians are going to cross the road. The first one stops since he is away from zebra crossing. The second one with dog is crossing through the zebra lines.	Hazard detection -Glance at both sides of the zebra crossing -Glance at first pedestrian *-Glance at second pedestrian* Mirror use -Glance at rear mirror (after detection of first or second pedestrian before braking)		X	X	X	N
12	The driver approaches the beginning of a built up area, were the cycle path turns into an adjacent cycle path. A bicyclist is riding on the cycle path.	Hazard detection -Glance at cyclist when approaching the bicycle path change *-Second glance at cyclist when he is proceeding onto the adjacent bicycle path*			X	X	F
13	The driver is driving through a complex school zone environment in the center of a city. To the right side of the road there is a large group of school children. When the vehicle approaches the zebra crossing, all of a sudden several school children cross the road.	Hazard detection -Glance at school zone sign -Glance at the group of children when approaching -Glance at other side of the zebra crossing when approaching *-Glance at crossing children* -Glance at group while passing by Mirror use -Glance at rear mirror (after glance at group of children before braking)			X	X	N

Hazard number	Hazard description	Critical visual search	Pre test	training	Post test	Retention test	Far/Near transfer
14	The driver is driving in a city center area, with parked vehicles on one side of the road. The road is wide enough for two passenger cars to cross each other. The driver first crosses a car from the opposite direction, afterwards a bus is about to cross the driver. There is enough space to pull aside to let the bus pass.	Hazard detection -Glance at parked cars *-Glance at approaching bus* Mirror use -Glance at rear mirror (after glance on bus and parked cars, before braking)			X	X	F
15	The driver is driving in a city center area with parked cars on each side. From between the parked cars, a pedestrian suddenly crosses.	Hazard detection -Glance at both parking areas *-Glance at child crossing* Mirror use -Glance at rear mirror (in anticipation of something happening)			X	X	N
16	The driver is driving on a double lane priority road and is followed by a car. Another car merges from right onto the priority road.	Hazard detection -Glance at traffic sign -Glance at the other road to detect possible vehicles *-Glance at vehicle* Mirror use -Glance at rear mirror (after glance on traffic sign or vehicle)		X	X	X	N

APPENDIX 5: Consent form

Informatie- en instemmingformulier

In dit onderzoek bestuderen wij rijgedrag met behulp van een rijsimulator. Tijdens elke rit worden er gegevens verzameld met betrekking tot de rijprestatie, deze gegevens worden volledig anoniem bewaard en geanalyseerd. Bijkomend worden er computergestuurde taken uitgevoerd en ook deze gegevens worden anoniem behandeld. Het kan zijn dat de gegevens anoniem doorgegeven worden voor ander wetenschappelijk onderzoek of dat resultaten van dit onderzoek worden gepubliceerd. Uw naam wordt als deelnemer niet gepubliceerd en de vertrouwelijkheid van de gegevens wordt in elk stadium van het onderzoek gewaarborgd.

Tijdens het onderzoek in de simulator bestaat de kans dat u last krijgt van misselijkheid of duizeligheid (ook gekend als ”simulatorziekte”). Wanneer dit het geval is, vragen wij u dit direct te melden in plaats van te wachten tot het eind van het onderzoek. U bent op elk moment vrij om te stoppen met het onderzoek.

Wij bedanken u voor uw deelname aan het onderzoek. Als een teken van onze dank ontvangt u een sodexo bon ter waarde van 20 euro. Bijkomend, kan uw deelname ook een maatschappelijke impact hebben door de invloed van dit onderzoek op het verkeersbeleid.

Instemmingverklaring

Ik, ondergetekende deelnemer, heb de bovenstaande informatie nauwkeurig gelezen en verleen mijn medewerking aan dit onderzoek van Weixin WANG (Onderzoeker, IMOB, UHasselt). Hierbij verklaar ik dat ik uit vrije wil deelneem aan dit onderzoek en geen vergoeding vraag voor eventuele ongemakken. Ook behoud ik het recht om op elk moment mijn deelname aan het onderzoek stop te zetten. Ik zal geen informatie over het experiment doorgeven aan andere mogelijke deelnemers en ik zal mij tijdens de rijsimulatie gedragen zoals ik mij normaal gedraag op de openbare weg.

Datum: ___ / ____ / ______

Handtekening van de onderzoeker:

Naam en handtekening van de proefpersoon:

APPENDIX 6: MDSI questionnaire

1- helemaal niet, 2 – zeer weinig, 3 – een beetje, 4 - gemiddeld, 5 - goed, 6- zeer goed							
1.	Ik voer vaak ontspannende activiteiten uit tijdens het rijden	1	2	3	4	5	6
2.	Ik rij vaak opzettelijk te dicht op andere bestuurders	1	2	3	4	5	6
3.	Ik toeter vaak of flikker vaak met mijn lichten naar de auto voor mij om mijn frustratie uit te drukken	1	2	3	4	5	6
4.	Ik heb het gevoel dat ik de controle heb over mijn rijden	1	2	3	4	5	6
5.	Ik rij vaak door verkeerslichten die juist rood geworden zijn	1	2	3	4	5	6
6.	Ik hou meestal van de sensatie om op de limiet te rijden (gevaarlijk)	1	2	3	4	5	6
7.	Op een lege snelweg rij ik meestal aan of een beetje onder de snelheidslimiet.	1	2	3	4	5	6
8.	Tijdens het rijden probeer ik mezelf te ontspannen	1	2	3	4	5	6
9.	Wanneer ik me in een verkeersopstopping bevind en de rij langs me begint te bewegen, dan ga ik me zo snel mogelijk naar die rij begeven	1	2	3	4	5	6
10.	Rijden doet me meestal gefrustreerd voelen	1	2	3	4	5	6
11.	Ik zit tijdens het rijden vaak te dagdromen om de tijd te doden	1	2	3	4	5	6
12.	Ik vloek vaak op andere bestuurders	1	2	3	4	5	6
13.	Wanneer een verkeerslicht groen wordt en de auto voor me vertrekt niet, dan wacht ik voor een tijdje tot die vertrekt	1	2	3	4	5	6
14.	Ik rijd voorzichtig	1	2	3	4	5	6
15.	Soms ben ik verloren in gedachte of afgeleid waardoor ik iemand die wacht aan een zebrapad/voetganger niet opmerk	1	2	3	4	5	6
16.	In een verkeersopstopping denk ik aan manieren om sneller door het verkeer uit te geraken	1	2	3	4	5	6
17.	Wanneer een verkeerslicht groen wordt en de auto voor me vertrekt niet onmiddellijk, dan probeer ik de bestuurder aan te zetten om te vertrekken	1	2	3	4	5	6
18.	Bij een kruispunt, waar ik voorrang van rechts moet geven, wacht ik geduldig tot het passerende verkeer voorbij is	1	2	3	4	5	6
19.	Wanneer iemand probeert om voor me in te voegen rij ik op een assertieve manier om dit te vermijden	1	2	3	4	5	6
20.	Ik werk vaak mijn haar of make-up bij terwijl ik aan het rijden ben	1	2	3	4	5	6
21.	Ik ben vaak afgeleid of gepreoccupeerd en besef dan plots dat het voertuig voor me vertraagd is, en ik moet dan hard remmen om een botsing te voorkomen	1	2	3	4	5	6
22.	Ik hou ervan om risico’s te nemen tijdens het rijden	1	2	3	4	5	6
23.	Ik baseer mijn gedrag op het motto “bezint eer ge begint” (better safe than sorry)	1	2	3	4	5	6
24.	Ik hou van de opwinding die ik krijg door met ongeluk en dood te flirten	1	2	3	4	5	6
25.	Ik ben ongerust om in slecht weer te rijden	1	2	3	4	5	6
26.	Ik mediteer vaak tijdens het rijden	1	2	3	4	5	6
27.	Verloren in gedachte vergeet ik vaak dat mijn lichten volledig opstaan totdat een andere bestuurder zijn lichten op me flikkert	1	2	3	4	5	6
28.	Wanneer iemand iets op de weg doet dat me stoort, flikker ik met mijn grote lichten	1	2	3	4	5	6
29.	Ik vind het spannend om de wet te breken	1	2	3	4	5	6
30.	Ik schat tijdens het passeren de snelheid van een aankomend voertuig vaak verkeerd in	1	2	3	4	5	6

1- helemaal niet, 2 – zeer weinig, 3 – een beetje, 4 - gemiddeld, 5 - goed, 6- zeer goed							
31.	Ik voel me nerveus tijdens het rijden	1	2	3	4	5	6
32.	Ik wordt ongeduldig tijdens het spitsuur	1	2	3	4	5	6
33.	Ik voel me ongelukkig tijdens het rijden	1	2	3	4	5	6
34.	Ik zet vaak mijn lichten aan in plaats van mijn ruitenwissers en visa versa	1	2	3	4	5	6
35.	Ik probeer vaak in de derde versnelling te vertrekken aan een verkeerslicht (of in neutraal met een automatische versnellingsbak)	1	2	3	4	5	6
36.	Ik plan mijn route vaak slecht zodat ik in verkeer terecht kom dat vermeden had kunnen worden	1	2	3	4	5	6
37.	Ik gebruik vaak spierontspannende oefeningen tijdens het rijden	1	2	3	4	5	6
38.	Ik plan lange trippen vaak op voorhand	1	2	3	4	5	6
39.	Vaak raak ik (of bijna) iets doordat ik de ruimte op een parkeerplaats slecht inschat	1	2	3	4	5	6
40.	Ik voel me comfortabel tijdens het rijden	1	2	3	4	5	6
41.	Ik ben altijd klaar om te reageren op onverwachte manoeuvres van andere bestuurders	1	2	3	4	5	6
42.	Ik heb meestal de neiging om voorzichtig te rijden	1	2	3	4	5	6
43.	Ik toeter vaak naar andere bestuurders	1	2	3	4	5	6
44.	Ik geniet meestal van de opwinding van gevaarlijk rijden	1	2	3	4	5	6

APPENDIX 7: SPSS outputs: Detection time

[A] - SPSS outputs Split-plot ANOVA - section 5.1 Analysis of detection time

- Normality

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
meandtpr	27	1,28	3,77	2,3259	,59249	,162	,448	,034	,872
meandtpo	27	,56	3,59	1,8389	,63238	,648	,448	1,168	,872
meandtret	23	,81	2,59	1,6835	,47730	,131	,481	-,551	,935
Valid N (listwise)	20								

- Sphericity

Mauchly's Test of Sphericity[a]

Measure: detectiontime

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b]		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
testtime	,994	,095	2	,953	,994	1,000	,500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept + EorC
 Within Subjects Design: testtime

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

- Homogeneity of inter-correlation

Box's Test of Equality of Covariance Matrices[a]

Box's M	3,105
F	,421
df1	6
df2	2068,114
Sig.	,865

Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.
a. Design: Intercept + EorC
Within Subjects Design: testtime

- Homogeneity of variance

Levene's Test of Equality of Error Variances[a]

	F	df1	df2	Sig.
meandtpr	,004	1	18	,952
meandtpo	,561	1	18	,464
meandtret	,106	1	18	,748

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.
a. Design: Intercept + EorC
Within Subjects Design: testtime

- Descriptive statistics

Descriptive Statistics

	EorC	Mean	Std. Deviation	N
meandtpr	control	2,3467	,53313	9
	experimental	2,4873	,59711	11
	Total	2,4240	,55900	20
meandtpo	control	2,2444	,65936	9
	experimental	1,7300	,46838	11
	Total	1,9615	,60619	20
meandtret	control	2,0856	,35683	9
	experimental	1,5127	,32404	11
	Total	1,7705	,44087	20

- Tests of within-subjects effects

Tests of Within-Subjects Effects

Measure: detectiontime

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
testtime	Sphericity Assumed	3,972	2	1,986	10,959	,000	,378	21,918	,986
	Greenhouse-Geisser	3,972	1,989	1,997	10,959	,000	,378	21,796	,985
	Huynh-Feldt	3,972	2,000	1,986	10,959	,000	,378	21,918	,986
	Lower-bound	3,972	1,000	3,972	10,959	,004	,378	10,959	,879
testtime * EorC	Sphericity Assumed	1,553	2	,777	4,287	,021	,192	8,573	,711
	Greenhouse-Geisser	1,553	1,989	,781	4,287	,022	,192	8,525	,709
	Huynh-Feldt	1,553	2,000	,777	4,287	,021	,192	8,573	,711
	Lower-bound	1,553	1,000	1,553	4,287	,053	,192	4,287	,500
Error(testtime)	Sphericity Assumed	6,523	36	,181					
	Greenhouse-Geisser	6,523	35,800	,182					
	Huynh-Feldt	6,523	36,000	,181					
	Lower-bound	6,523	18,000	,362					

a. Computed using alpha = ,05

- Tests of between-subjects effects

Tests of Between-Subjects Effects

Measure: detectiontime

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Intercept	253,977	1	253,977	647,863	,000	,973	647,863	1,000
EorC	1,479	1	1,479	3,772	,068	,173	3,772	,452
Error	7,056	18	,392					

a. Computed using alpha = ,05

- Estimates

Estimates

Measure: detectiontime

testtime	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	2,417	,128	2,148	2,686
2	1,987	,126	1,722	2,252
3	1,799	,076	1,639	1,959

Estimates

Measure: detectiontime

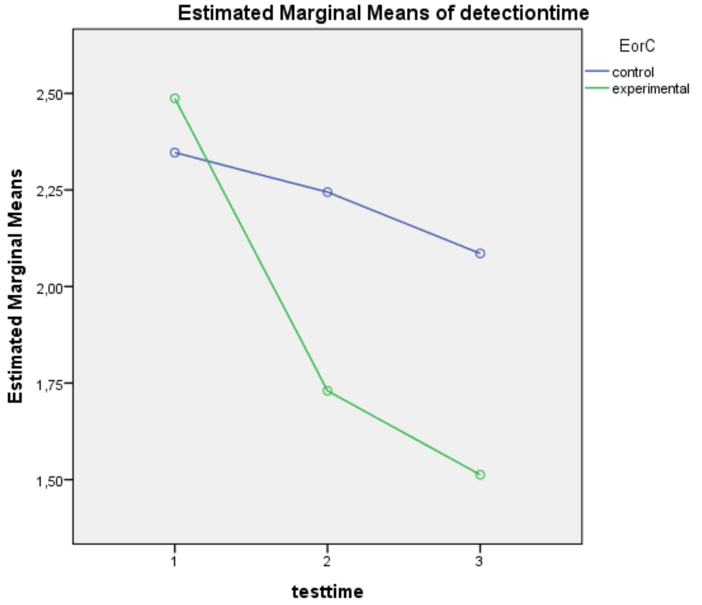
EorC	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
control	2,226	,120	1,972	2,479
experimental	1,910	,109	1,681	2,139

4. EorC * testtime

Measure: detectiontime

EorC	testtime	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
control	1	2,347	,190	1,948	2,746
	2	2,244	,187	1,851	2,638
	3	2,086	,113	1,848	2,323
experimental	1	2,487	,172	2,126	2,848
	2	1,730	,169	1,374	2,086
	3	1,513	,102	1,298	1,727

- Spss plot



[B] - SPSS outputs paired sample t-test - section 5.1 Analysis of detection time

- Normality

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
meandtponear	,186	11	,200*	,961	11	,785
meandtretnear	,138	11	,200*	,952	11	,666
meandtpofar	,164	11	,200*	,943	11	,562
meandtretfar	,182	11	,200*	,901	11	,190

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

- t-test

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	meandtponear	,9279	14	,60423	,16149
	meandtpofar	1,7579	14	,36939	,09872
Pair 2	meandtretnear	,7475	12	,44206	,12761
	meandtretfar	1,5350	12	,42569	,12289

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	meandtponear - meandtpofar	-,83000	,52386	,14001	-1,13247	-,52753	-5,928	13	,000
Pair 2	meandtretnear - meandtretfar	-,78750	,68016	,19635	-1,21965	-,35535	-4,011	11	,002

[C] - SPSS outputs post hoc two-way ANOVA - section 5.1 Analysis of detection time

- Pretetst

Estimates

Dependent Variable: meandtpr

EorC	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
control	2,308	,168	1,963	2,653
experimental	2,343	,161	2,010	2,675

Pairwise Comparisons

Dependent Variable: meandtpr

(I) EorC	(J) EorC	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
control	experimental	-,035	,233	,881	-,514	,444
experimental	control	,035	,233	,881	-,444	,514

Based on estimated marginal means

a. Adjustment for multiple comparisons: Bonferroni.

Univariate Tests

Dependent Variable: meandtpr

	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Contrast	,008	1	,008	,023	,881	,001	,023	,052
Error	9,119	25	,365					

The F tests the effect of EorC. This test is based on the linearly independent pairwise comparisons among the estimated marginal means.

a. Computed using alpha = ,05

- Posttest

Estimates

Dependent Variable: meandtpo

EorC	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
control	2,183	,162	1,850	2,516
experimental	1,563	,145	1,266	1,861

Pairwise Comparisons

Dependent Variable: meandtpo

(I) EorC	(J) EorC	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
control	experimental	,620*	,217	,008	,173	1,067
experimental	control	-,620*	,217	,008	-1,067	-,173

Based on estimated marginal means

*. The mean difference is significant at the ,05 level.

b. Adjustment for multiple comparisons: Bonferroni.

Univariate Tests

Dependent Variable: meandtpo

	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Contrast	2,563	1	2,563	8,177	,008	,246	8,177	,785
Error	7,835	25	,313					

The F tests the effect of EorC. This test is based on the linearly independent pairwise comparisons among the estimated marginal means.

a. Computed using alpha = ,05

- Retention test

Estimates

Dependent Variable: meandtret

EorC	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
control	1,905	,131	1,632	2,178
experimental	1,481	,126	1,219	1,742

Pairwise Comparisons

Dependent Variable: meandtret

(I) EorC	(J) EorC	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
control	experimental	,424*	,182	,030	,046	,802
experimental	control	-,424*	,182	,030	-,802	-,046

Based on estimated marginal means

*. The mean difference is significant at the ,05 level.

b. Adjustment for multiple comparisons: Bonferroni.

Univariate Tests

Dependent Variable: meandtret

	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Contrast	1,030	1	1,030	5,434	,030	,206	5,434	,604
Error	3,982	21	,190					

The F tests the effect of EorC. This test is based on the linearly independent pairwise comparisons among the estimated marginal means.

a. Computed using alpha = ,05

APPENDIX 8: SPSS outputs: Collision

[A] - SPSS outputs Fisher's exact test - section 5.2 Analysis of collision

- Pretest

EorC * sumcolpr Crosstabulation

Count

		sumcolpr		Total
		,00	1,00	
EorC	control	12	2	14
	experimental	12	3	15
Total		24	5	29

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	,166[a]	1	,684		
Continuity Correction[b]	,000	1	1,000		
Likelihood Ratio	,167	1	,683		
Fisher's Exact Test				1,000	,535
N of Valid Cases	29				

a. 2 cells (50,0%) have expected count less than 5. The minimum expected count is 2,41.

b. Computed only for a 2x2 table

- Posttest

EorC * sumcolpo Crosstabulation

Count

		sumcolpo		Total
		,00	1,00	
EorC	control	12	2	14
	experimental	15	0	15
Total		27	2	29

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	2,302[a]	1	,129		
Continuity Correction[b]	,614	1	,433		
Likelihood Ratio	3,072	1	,080		
Fisher's Exact Test				,224	,224
N of Valid Cases	29				

a. 2 cells (50,0%) have expected count less than 5. The minimum expected count is ,97.

b. Computed only for a 2x2 table

[B] - SPSS outputs Wilcoxon rank test - section 5.2 Analysis of collision

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum	Percentiles		
						25th	50th (Median)	75th
sumcolponear	15	,4000	,50709	,00	1,00	,0000	,0000	1,0000
sumcolretnear	15	,0667	,25820	,00	1,00	,0000	,0000	,0000
sumcolpofar	15	,0000	,00000	,00	,00	,0000	,0000	,0000
sumcolretfar	15	,0000	,00000	,00	,00	,0000	,0000	,0000

Ranks

		N	Mean Rank	Sum of Ranks
sumcolpofar - sumcolponear	Negative Ranks	6[a]	3,50	21,00
	Positive Ranks	0[b]	,00	,00
	Ties	9[c]		
	Total	15		
sumcolretfar - sumcolretnear	Negative Ranks	1[d]	1,00	1,00
	Positive Ranks	0[e]	,00	,00
	Ties	14[f]		
	Total	15		

a. sumcolpofar < sumcolponear

b. sumcolpofar > sumcolponear

c. sumcolpofar = sumcolponear

d. sumcolretfar < sumcolretnear

e. sumcolretfar > sumcolretnear

f. sumcolretfar = sumcolretnear

Test Statistics[a]

	sumcolpofar - sumcolponear	sumcolretfar - sumcolretnear
Z	-2,449[b]	-1,000[b]
Asymp. Sig. (2-tailed)	,014	,317

a. Wilcoxon Signed Ranks Test

b. Based on positive ranks.

APPENDIX 9: SPSS outputs: Correct hazard detection

[A] - SPSS outputs Split-plot ANOVA - section 5.3 Analysis of correct hazard detection

- Sphericity

Mauchly's Test of Sphericity[a]

Measure: hazarddetection

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b]		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
testtime	,940	1,047	2	,592	,944	1,000	,500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept + EorC

Within Subjects Design: testtime

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

- Homogeneity of inter-correlation

Box's Test of Equality of Covariance Matrices[a]

Box's M	8,364
F	1,134
df1	6
df2	2068,114
Sig.	,340

Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.

a. Design: Intercept + EorC

Within Subjects Design: testtime

- Homogeneity of variance

Levene's Test of Equality of Error Variances[a]

	F	df1	df2	Sig.
meanhdpr	,618	1	18	,442
meanhdpo	3,495	1	18	,078
meanhdret	,535	1	18	,474

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + EorC

Within Subjects Design: testtime

- Descriptive statistics

Descriptive Statistics

	EorC	Mean	Std. Deviation	N
meanhdpr	control	74,4217	10,70897	9
	experimental	74,2850	8,66894	11
	Total	74,3465	9,37256	20
meanhdpo	control	80,4419	12,86554	9
	experimental	88,3722	6,37894	11
	Total	84,8036	10,36794	20
meanhdret	control	77,1050	10,18078	9
	experimental	91,4773	7,51851	11
	Total	85,0098	11,27863	20

- Tests of within-subjects effects

Tests of Within-Subjects Effects

Measure: hazarddetection

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
testtime	Sphericity Assumed	1319,002	2	659,501	7,539	,002	,295	15,078	,925
	Greenhouse-Geisser	1319,002	1,887	698,890	7,539	,002	,295	14,228	,913
	Huynh-Feldt	1319,002	2,000	659,501	7,539	,002	,295	15,078	,925
	Lower-bound	1319,002	1,000	1319,002	7,539	,013	,295	7,539	,738
testtime * EorC	Sphericity Assumed	523,191	2	261,595	2,990	,063	,142	5,981	,545
	Greenhouse-Geisser	523,191	1,887	277,220	2,990	,066	,142	5,644	,528
	Huynh-Feldt	523,191	2,000	261,595	2,990	,063	,142	5,981	,545
	Lower-bound	523,191	1,000	523,191	2,990	,101	,142	2,990	,374
Error(testtime)	Sphericity Assumed	3149,259	36	87,479					
	Greenhouse-Geisser	3149,259	33,971	92,704					
	Huynh-Feldt	3149,259	36,000	87,479					
	Lower-bound	3149,259	18,000	174,959					

a. Computed using alpha = ,05

- Tests of between-subjects effects

Tests of Between-Subjects Effects

Measure: hazarddetection

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Intercept	389888,867	1	389888,867	4265,604	,000	,996	4265,604	1,000
EorC	810,684	1	810,684	8,869	,008	,330	8,869	,804
Error	1645,254	18	91,403					

a. Computed using alpha = ,05

- Estimates

Estimates

Measure: hazarddetection

EorC	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
control	77,323	1,840	73,457	81,188
experimental	84,711	1,664	81,215	88,208

Estimates

Measure: hazarddetection

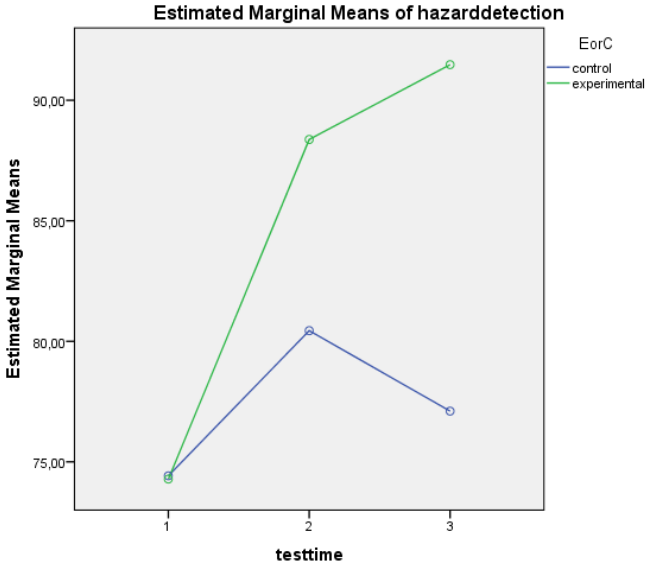
testtime	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	74,353	2,164	69,807	78,900
2	84,407	2,204	79,777	89,037
3	84,291	1,978	80,135	88,447

4. EorC * testtime

Measure: hazarddetection

EorC	testtime	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
control	1	74,422	3,210	67,678	81,165
	2	80,442	3,269	73,574	87,310
	3	77,105	2,934	70,941	83,269
experimental	1	74,285	2,903	68,185	80,385
	2	88,372	2,957	82,160	94,584
	3	91,477	2,654	85,902	97,053

- Spss plot



[B] - SPSS outputs paired sample t-test - section 5.3 Analysis of correct hazard detection

- Normality

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
meanhdponear	,124	14	,200*	,936	14	,364
meanhdretnear	,233	14	,038	,879	14	,057
meanhdpofar	,209	14	,100	,910	14	,160
meanhdretfar	,201	14	,131	,890	14	,081

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

- t-test

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	meanhdponear	86,2007	15	8,97918	2,31842
	meanhdpofar	89,1513	15	8,08864	2,08848
Pair 2	meanhdretnear	92,0829	14	6,86567	1,83493
	meanhdretfar	92,2464	14	7,68157	2,05299

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	meanhdponear - meanhdpofar	-2,95067	10,46705	2,70258	-8,74712	2,84579	-1,092	14	,293
Pair 2	meanhdretnear - meanhdretfar	-,16357	10,06969	2,69124	-5,97764	5,65049	-,061	13	,952

APPENDIX 10: SPSS outputs: Rear mirror use

[A] - SPSS outputs Split-plot ANOVA - section 5.4 Analysis of mirror use

- Normality

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
meanhhpr	28	,00	,80	,3044	,21148	,688	,441	,263	,858
meanhhpo	29	,00	,89	,4676	,31014	-,281	,434	-1,158	,845
meanhhret	24	,00	1,00	,5220	,35459	-,322	,472	-1,422	,918
Valid N (listwise)	23								

- Sphericity

Mauchly's Test of Sphericity[a]

Measure: rearmirroruse

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b]		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
testtime	,860	3,006	2	,223	,878	,997	,500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.
a. Design: Intercept + EorC
Within Subjects Design: testtime
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

- Homogeneity of inter-correlation

Box's Test of Equality of Covariance Matrices[a]

Box's M	7,176
F	1,003
df1	6
df2	2605,385
Sig.	,421

Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.
a. Design: Intercept + EorC
Within Subjects Design: testtime

- Homogeneity of variance

Levene's Test of Equality of Error Variances[a]

	F	df1	df2	Sig.
meanhhpr	,789	1	21	,384
meanhhpo	,362	1	21	,554
meanhhret	2,941	1	21	,101

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + EorC

Within Subjects Design: testtime

- Descriptive statistics

Descriptive Statistics

	EorC	Mean	Std. Deviation	N
meanhhpr	control	,3925	,23898	10
	experimental	,2372	,18090	13
	Total	,3047	,21774	23
meanhhpo	control	,2278	,21667	10
	experimental	,6928	,20281	13
	Total	,4906	,31176	23
meanhhret	control	,1667	,19772	10
	experimental	,8098	,11722	13
	Total	,5302	,36023	23

- Tests of within-subjects effects

Tests of Within-Subjects Effects

Measure: rearmirroruse

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
testtime	Sphericity Assumed	,392	2	,196	6,650	,003	,240	13,299	,893
	Greenhouse-Geisser	,392	1,755	,223	6,650	,005	,240	11,671	,860
	Huynh-Feldt	,392	1,994	,197	6,650	,003	,240	13,257	,892
	Lower-bound	,392	1,000	,392	6,650	,018	,240	6,650	,691
testtime * EorC	Sphericity Assumed	1,986	2	,993	33,696	,000	,616	67,393	1,000
	Greenhouse-Geisser	1,986	1,755	1,132	33,696	,000	,616	59,141	1,000
	Huynh-Feldt	1,986	1,994	,996	33,696	,000	,616	67,179	1,000
	Lower-bound	1,986	1,000	1,986	33,696	,000	,616	33,696	1,000
Error(testtime)	Sphericity Assumed	1,238	42	,029					
	Greenhouse-Geisser	1,238	36,857	,034					
	Huynh-Feldt	1,238	41,867	,030					
	Lower-bound	1,238	21,000	,059					

a. Computed using alpha = ,05

- Tests of between-subjects effects

Tests of Between-Subjects Effects

Measure: rearmirroruse

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Intercept	12,028	1	12,028	229,242	,000	,916	229,242	1,000
EorC	1,711	1	1,711	32,600	,000	,608	32,600	1,000
Error	1,102	21	,052					

a. Computed using alpha = ,05

- Estimates

Estimates

Measure: rearmirroruse

EorC	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
control	,262	,042	,175	,349
experimental	,580	,037	,504	,656

Estimates

Measure: rearmirroruse

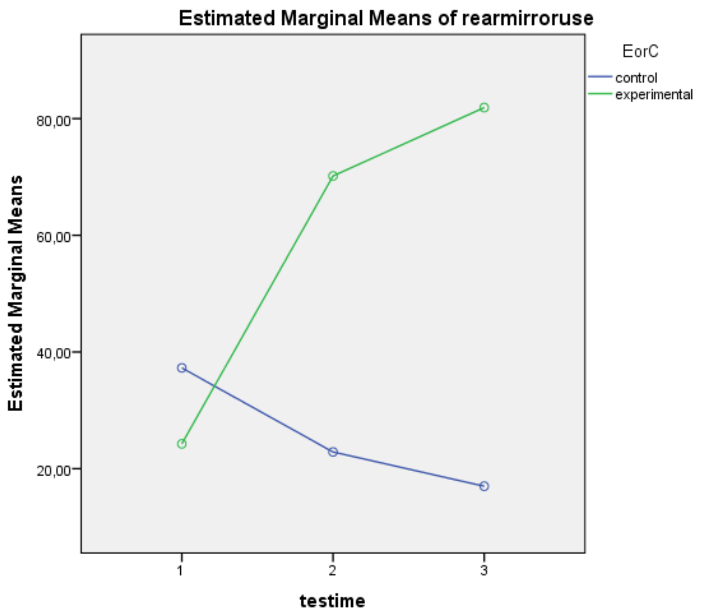
testtime	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	,315	,044	,224	,406
2	,460	,044	,369	,552
3	,488	,033	,420	,557

4. EorC * testtime

Measure: rearmirroruse

EorC	testtime	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
control	1	,393	,066	,256	,529
	2	,228	,066	,090	,365
	3	,167	,050	,064	,270
experimental	1	,237	,058	,117	,357
	2	,693	,058	,572	,813
	3	,810	,044	,719	,900

- Spss plot



[B] - SPSS outputs paired sample t-test - section 5.4 Analysis of mirror use

- Normality

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
meanhhponear	,192	12	,200*	,939	12	,481
meanhhretnear	,224	12	,098	,918	12	,274
meanhhpofar	,168	12	,200*	,947	12	,599
meanhhretfar	,201	12	,194	,943	12	,535

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

- t-test

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	meanhhponear	,6573	15	,22407	,05785
	meanhhpofar	,6787	15	,22068	,05698
Pair 2	meanhhretnear	,7458	12	,13338	,03850
	meanhhretfar	,7842	12	,15294	,04415

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	meanhhponear - meanhhpofar	-,02133	,19149	,04944	-,12738	,08471	-,431	14	,673
Pair 2	meanhhretnear - meanhhretfar	-,03833	,13849	,03998	-,12632	,04966	-,959	11	,358

[C] - SPSS outputs post hoc two-way ANOVA - section 5.4 Analysis of mirror use

- Pretest

Estimates

Dependent Variable: meanhhpr

EorC	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
control	,347	,059	,226	,467
experimental	,268	,055	,155	,380

Pairwise Comparisons

Dependent Variable: meanhhpr

(I) EorC	(J) EorC	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
control	experimental	,079	,080	,332	-,086	,244
experimental	control	-,079	,080	,332	-,244	,086

Based on estimated marginal means

a. Adjustment for multiple comparisons: Bonferroni.

Univariate Tests

Dependent Variable: meanhhpr

	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Contrast	,044	1	,044	,976	,332	,036	,976	,158
Error	1,164	26	,045					

The F tests the effect of EorC. This test is based on the linearly independent pairwise comparisons among the estimated marginal means.

a. Computed using alpha = ,05

- Posttest

Estimates

Dependent Variable: meanhhpo

EorC	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
control	,230	,056	,116	,344
experimental	,689	,054	,579	,799

Pairwise Comparisons

Dependent Variable: meanhhpo

(I) EorC	(J) EorC	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
control	experimental	-,459*	,077	,000	-,618	-,301
experimental	control	,459*	,077	,000	,301	,618

Based on estimated marginal means

*. The mean difference is significant at the ,05 level.

b. Adjustment for multiple comparisons: Bonferroni.

Univariate Tests

Dependent Variable: meanhhpo

	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Contrast	1,526	1	1,526	35,324	,000	,567	35,324	1,000
Error	1,167	27	,043					

The F tests the effect of EorC. This test is based on the linearly independent pairwise comparisons among the estimated marginal means.

a. Computed using alpha = ,05

- Retention test

Estimates

Dependent Variable: meanhhret

EorC	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
control	,250	,065	,116	,384
experimental	,810	,062	,681	,938

Pairwise Comparisons

Dependent Variable: meanhhret

(I) EorC	(J) EorC	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
control	experimental	-,560*	,090	,000	-,745	-,374
experimental	control	,560*	,090	,000	,374	,745

Based on estimated marginal means

*. The mean difference is significant at the ,05 level.

b. Adjustment for multiple comparisons: Bonferroni.

Univariate Tests

Dependent Variable: meanhhret

	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Contrast	1,956	1	1,956	38,923	,000	,629	38,923	1,000
Error	1,156	23	,050					

The F tests the effect of EorC. This test is based on the linearly independent pairwise comparisons among the estimated marginal means.

a. Computed using alpha = ,05

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