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School of Transportation Sciences

Master of Transportation Sciences

Master's thesis

Hazard perception skills: a simulator study comparing young autistic and non-autistic drivers

Jana Horemans
Thesis presented in fulfillment of the requirements for the degree of Master of Transportation Sciences, specialization Traffic Safety

SUPERVISOR :
Prof. dr. Kris BRIJS

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Abstract

Hazard perception is considered a foundational skill in driving. However, research indicates that autistic adults perform worse on these skills. Hazards can be divided in three categories: behavioural prediction (BP), environmental prediction (EP) and dividing and focusing (DF). The objectives of this study were to (1) determine if drivers with autistic traits performed differently from control drivers to hazardous situations, (2) compare the different types of hazards (BP, EP, and DF), and (3) compare the self-reported hazard perception skills between both groups. A group of 12 drivers with autistic traits and 16 control drivers completed a self-report measurement and a driving simulator test consisting of two trips containing 9 hazards (3 BP, 3 EF, and 3 DF). No significant differences between groups were found in reaction time, time to collision or speed. This indicates that drivers with autistic traits are equally capable drivers as the control drivers regarding hazard perception. The self-reported measures revealed that for DF hazards, the drivers with autistic traits had a better recognition rate, and they perceived them as less difficult compared to the control group. In both groups, the reaction time toward the DF hazards was significantly slower than for the other hazards. Future research on the difference between these three types of hazards can elaborate more on different age groups and should include more drivers with an official autism diagnosis.

Highlights

- This is one of few studies comparing hazard perception in autistic and non-autistic drivers.
- Drivers with autism traits are adept skilled as control drivers regarding hazard perception.
- Training of hazard perception skills is a valuable addition to learning to drive.
- Future research should take different types of hazards into account.

Keywords

Autism spectrum disorder, hazard perception, driving simulation, driving behaviour, driving simulator

1 Introduction

1.1 Autism spectrum disorder

Autism spectrum disorder (ASD) is a form of pervasive developmental condition. These conditions are defined by qualitative impairments in the development of verbal and nonverbal communication skills, the development of reciprocal social interaction, and imaginative activity. The integration of these five disorders in the fifth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) is presented with new criteria, comprised of five symptom clusters: (1) social communication and social interaction, (2) restricted, repetitive behaviours and interests, (3) symptoms must be present in early development but may not fully manifest until later or may be masked later in life by learned strategies, (4) symptoms must cause clinically significant impairment in current functioning and (5) not better explained by intellectual disability or global developmental delay (American Psychiatric Association, 2013).

An extensive amount of studies estimating autism prevalence exist. A global review indicated that the median prevalence of autism equals 1/100. The estimates in the studies ranged from 1.09/100000 to 436.0/100000 and varied largely between sociodemographic groups (Zeidan et al., 2022). The sex ratio for males to females is estimated at 3:1 (Loomes et al., 2017). However, the sex ratio could be askew since females tend to mask their autism more than men do. This phenomenon is known as camouflaging, it is defined as the use of explicit techniques to hide social incompetence and preventing others from seeing this (Hull et al., 2017). Hull et al. (2017) described it as a combination of masking and compensation behaviours with the goal of fitting in. It requires the use of compensating behaviours, such as staying in groups with peers in order to hide their social challenges (Dean et al., 2016). This behaviour is more common in females than in males (Lai et al., 2016b; Schuck et al., 2019; Tubío-Fungueiriño et al., 2020), and more accepted in the female social landscape (Dean et al., 2016). Furthermore, females tend to have less stereotyped characteristics such as repetitive behaviour (Kreiser & White, 2013; van Wijngaarden-Cremers et al., 2013), which, in addition to the camouflaging, might explain the lower diagnostic rate.

Research on ethnic distribution is inconclusive (Elsabbagh et al., 2012, Magnusson et al., 2012, Goodman & Richards, 1995, Dyches et al., 2004, Keen et al., 2010). The prevalence of autism is higher for mental health patients (Tromans et al., 2018). Family studies revealed that genes significantly contribute to autism (Cross-Disorder Group of the Psychiatric Genomics Consortium, 2013, Gaugler et al., 2014). With more than 100 genes and genomic regions associated with autism (Sanders et al., 2015, Satterstrom et al., 2020), it is one of the most heritable common medical conditions (K. Wang et al., 2017). Other possible causes for autism include, but or not limited to, environmental factors such as chemicals (Landrigan, 2010; Hertz-Picciotto et al., 2018) and extreme traumatic experiences (Rowland, 2020)

1.2 Driving behaviour of autistic drivers

Learning to drive is an essential event in maturing since it offers the new driver a few benefits. First of all, it creates more freedom and independence (Collia et al., 2003). New drivers also gain more freedom from the family setting, since they can do individual things without depending on their parents (Best, 2006). Driving improves the chances of finding a job, maintaining social relations, and fulfilling education (Ellaway et al., 2003). A focus group study containing young adults with autism and their parents, indicated that due to transportation problems, the young adults with autism can feel isolated, depressed, and have a lack of self-confidence. Driving has a direct relation with the social, physical, and economical well-being (Feeley et al., 2015).

Even though driving is important to gain independence, a longitudinal study that was carried out in the United States shows that, while 83,5% of non-autistic learning drivers acquire their permanent driver's license, only one in three autism drivers acquires their permit. It should be noted that some people with autism don't want a license or have driving anxiety. In a survey study of Cox et al. (2012), 15% of the participants with autism did not possess a license. The main reason (46%) for this was the lack of interest. Other reasons included, but were not limited to, anxiety and parental concerns. Besides the lower licensing rate, the length of the learning period is, on average longer than for non-autistic drivers with 9.2 months (Curry, 2017).

The lower driver licensing rate can be due to the fact that for autistic people, driving can be even more difficult due to their struggles with driving-related skills. A literature review of Silvi et al. (2017)

indicated that autistic drivers performed worse on identification of social hazards, experienced more tactical driving difficulties, reacted slower, were involved in more traffic incidents, and showed poorer situation awareness. Most of these consequences come from the issues autistic people experience in the conceptual domain. One of the biggest factors in this domain is executive functioning. There are multiple studies that indicate that autistic people experience difficulties with executive functions (Hill, 2004; Lai et al., 2016a; Walshe et al., 2017; Ross et al., 2019; Bednarz et al., 2021a). These functions include for instance working memory, which is lower for people with autism than for non-autistic people (Rapport et al., 2013; Kercood et al., 2014; Y. Wang et al., 2017). Working memory is used for information monitoring, updating and manipulation that relates to visual, spatial, and verbal information. This includes the monitoring of multiple tasks, such as controlling the speed of the vehicle, as well as the lateral position (McCabe et al., 2010; Baddeley, 2012; Diamond, 2013). Another executive function is inhibitory control. This includes the capacity to filter distracting factors and resist irrelevant sensory information (Miyake et al., 2000; Brydges et al., 2013; Diamond, 2013). According to Kana et al. (2007), the inhibition circuitry of autistic people was activated atypically and less synchronized, indicating that their automatic inhibitory control was developed less than non-autistic people. This signifies that autistic people have to put more effort into filtering irrelevant information. Besides executive functioning, drivers with autism also experience difficulties with fitness to drive skills, such as cognition, motor coordination, speed regulation, lane maintenance and operational skills (Fournier et al., 2010; Classen et al., 2013; Myers et al., 2021). Driving can also lead to a sensory overload due to elements such as light, noise, being rushed. This causes additional pressure on driving performance, traffic analysing skills and obeying the traffic rules (Dirix et al., 2021). Therefore, novice autistic drivers experience multiple difficulties regarding to driving.

According to Curry et al. (2021), autistic drivers are involved in fewer incidents. Compared to non-autistic drivers, they are less likely to crash due to high speed. Autistic drivers are more likely to crash due to failing to give right of way to vulnerable road users or by making turns. Research of Ross et al. (2019) and Cox et al. (2020) indicated that autistic drivers were equally capable as non-autistic drivers, despite performing worse on executive functioning or on simulator tests. These results show that autistic drivers aren't more dangerous on the road than non-autistic drivers, even though they might find it more difficult to drive.

1.3 Hazard perception

According to Horswill & McKenna (2004), hazard perception can be described as the ability to predict traffic conditions, in special, road hazards. It is a form of situation awareness. Endsley (1995) divides hazard perception in three levels: perception of elements in the environment (level 1), comprehension of the situation (level 2) and projection of the development of the situation (level 3). Thus, the author describes hazard perception as the ability to detect (level 1), understand (level 2) and predict (level 3) of possible hazards. Hazard perception is considered a critical foundation skill of decision-making (Endsley, 1995). A driver with improved hazard perception skills is better at recognizing potential crash situations and anticipating the risk (Horswill, 2016b). Research has shown that hazard perception skills are related to crash rates both prospectively (Horswill, Hill, et al., 2015; Wells et al., 2008) and retrospectively (Boufous et al., 2011; Cheng et al., 2011; Congdon, 1999; Darby et al., 2009; Horswill et al., 2010; Horswill, Hill, et al., 2015; McKenna & Horswill, 1999; Pelz & Krupat, 1974; Quimby et al., 1986; Rosenbloom et al., 2011; Tūskė et al., 2019). Unfortunately, young novice drivers take longer to master hazard perception skills since they are more complex than basic vehicle handling skills (Hall & West, 1996; Deery, 1999; Freydier et al., 2016). As novice drivers gain experience, they shift from using largely fixated visual search strategies, to more efficient search patterns. Furthermore, they acquire more knowledge about typical traffic situations and related hazards. These two elements help to improve hazard perception skills but take some time to master (Brwon & Groeger, 1988). Furthermore, young drivers have a higher risk acceptance (Deery, 1999).

Hazard perception skills can be measured in various ways. Two types of tests can be identified. The first tests are computer tests, in which participants are shown videos of traffic situations. As soon as they recognize danger, they are asked to respond with a mouse click or button. The focus of these tests is the reaction time of participants. Reaction time has a significant relation with on-road driving performances (Grayson et al., 2003; Jones Ross et al., 2015; Wood et al., 2013). According to Horswill (2016a), the advantage of this test is the separation of all other driving skills since it only focuses on hazard perception. However, these tests do not always include spatial awareness, which can be used to measure accuracy of the location of the hazard (Isler et al., 2009; Wetton et al., 2010). A disadvantage of these tests is there is no way to measure prediction of hazards. According to Vlakveld et al. (2014) hazards that do not turn into acute threats should also be included in hazard perception tests. The second type of tests are questionnaires. Most of the questionnaires are based on the Situational Awareness Global Assessment Technique (SAGAT), in which participants are shown a clip and are than asked to answer questions about their understanding of the hazard (Endsley, 1988). These tests often use the WWW format: (a) What? identification of the hazard, (b) Where? accuracy of the location and (c) What happens next?/What would you do next? prediction of the development/ reaction to the hazard (Endsley, 1995; Jackson et al., 2009; Gugliotta et al., 2017). Lastly, the Hazard Perception Skill Instrument is a form of a self-reported measurement. In this questionnaire, drivers compare their own hazard perception skills to other drivers (White et al., 2011).

Most studies categorize hazards as social and non-social hazards (Sheppard et al., 2009; Sheppard et al., 2016; Bishop, 2016; Bishop et al., 2017; Bednarz et al., 2021b; Bednarz et al., 2021c). Another distinction uses three categories: behavioural prediction, environmental prediction, and dividing and focusing attention. Behavioural prediction (BP) hazards focus on the anticipation of events. They require the extrapolation of social elements in the environment to predict possible future events. In this category of hazards, there is a direct link between the precursor and the hazard, e.g. a car pulling up from a side road in front of the participant. Environmental prediction (EP) hazards have an indirect link between the precursor and the hazard. This creates the element of surprise. A certain understanding of statistical probabilities is needed to predict these hazards, e.g. a parked truck behind a blind bend. Dividing and focusing (DF) hazards occur when there are multiple potential hazards. At first, the drivers have to divide their attention on the different precursors. A precursor is a visual cue, e.g. the current behaviour that provides information for what might subsequently happen. After one of the precursors turns into an actual hazard, the driver must focus on this (Crundall et al., 2012).

Previous research by Ross et al. (2019) showed that for BP hazards, there is no difference in reaction time and time to collision at the moment of the reaction between the control group and autism group. The reaction time to EP hazards was smaller for people with autism. The difference in reaction time to BP and EF hazards for drivers with autism can be explained by the explicitness of the situation. The behavioural context is more open to interpretation than the environmental context (Vermeulen, 2009). Lastly, the drivers with autism performed worse on the DF hazards, as they had a slower reaction time than the non-autistic drivers. However, the study contained a limited number of hazards for every type (Ross et al., 2019).

2 Objectives

As indicated in the introduction, limited research regarding hazard perception and autism has been carried out, especially using the BP, EP and DF categorisation. Therefore, this research, which is a part of a bigger project in Qatar, contains two main objectives. The first is to compare the hazard perception skills of car drivers with autistic traits and control car drivers. Furthermore, there will also be a comparative part regarding the types of hazards and how they influence the reaction of both types of drivers.

Sub-objectives support the main objectives. First, this research will include a comparison between the different types of hazards and their precursors. Furthermore, the variable reaction will be researched as a way of measuring the reaction to hazards. Third, a self-assessment will be used to measure self-perceived skills. This will then be compared with the actual results of the research. Lastly, this study will analyse the variables gender, license, and confidence within both the control group and the autistic traits group.

3 Research questions/hypotheses

3.1 Main research question

- What are the differences between young adult car drivers with autism traits and the control car drivers regarding their hazard perception skills?

3.2 Sub research questions

- Do drivers with autism traits recognize all types of hazards (BP, EP, DF)?
- Is there a difference in recognition of the different precursors?
- Does the type of hazard precursor influence the reaction time of the driver?
- Is there a difference between autism traits drivers and the control drivers regarding the reaction?
- Do drivers with autism traits have a different reaction time towards hazards than the control drivers?
- Do the hazard perception skills of male and female drivers with autistic traits and the control drivers differ?
- Is there a difference in the demonstration of hazard perception skills between drivers with autistic traits and the control drivers with more driving exposure?
- Is there a difference in the demonstration of hazard perception skills between drivers with autistic traits and the control drivers with more confidence?

4 Methodology

4.1 Participants

A total of 28 drivers participated in the study. All drivers were between 18 and 25 years old. The recruitment was carried out via posts on social media. Every participant filled an adapted Autism Quotient questionnaire beforehand. Participants with a score higher than 8 were placed in the autism trait group. The final sample of the control group consisted of 16 drivers (9 males; mean age = 21,00 years; SD = 1,698). The autistic traits group consisted of 12 drivers (6 males; mean age = 21,31 years; SD = 1,229). There was no significant difference in the age distribution between both groups (Mann-Whitney U = 111,50; z = 0,720; p = 0,478). Neither were there gender differences ($\chi^2 = 0{,}108$; p = 0,743) or a distribution difference in licensing ($\chi^2 = 1{,}197$; p = 0,274).

It is common for autism to co-occur with other disorders. The presence of one or more disorders in addition to a primary disorder, in this case autism, is known as comorbidity. Depending on the age and the intellectual abilities of autism cases, the prevalence of a comorbid disorder ranges from 46,1% to 95% (Mannion et al., 2013; Soke et al., 2018). Because it so common, this study does not exclude comorbidity.

All participants signed an informed consent before the start of the study. Every participant had an equal chance (1/28) of winning a gift coupon of 20 euros for their participation.

4.2 Procedure

All drivers participated in different studies. Therefore, they completed five tasks during the testing: (1) a demographic questionnaire, (2) a simulator drive that focused on hazard perception, (3) a simulator drive that focused on emotion regulation, (4) the lane change task and (5) a post-questionnaire for all simulator drives. This study will only focus on the hazard perception drives. This research was approved by the ethical committee of Hasselt University (reference number CME2021/069).

4.2.1 Pre-questionnaires

4.2.1.1 Demographic questionnaire

The demographic questionnaire was used to collect the basic information about the participants such as age, gender, the date they obtained their license and their driving experience.

4.2.1.2 Autism Quotient

For this research an adapted version of the AQ-test was used. The Autism-Spectrum Quotient (Baron-Cohen et al., 2001) is an instrument that can be used to determine an individual's position on the spectrum. It was a rapid option to decide what level of autism symptoms are present in the participant's life. It focused on the 5 most important areas regarding autism traits: social skills, attention switching, attention to detail, communication, and imagination. It consists of a series of 50 questions which leads to a score on 50. The higher the score, the more autistic traits the participant had.
The adapted AQ-test contains 22 questions and was based on the shortened QA-10. This version was created by the authors because the original AQ and the AQ-10 were reported to be biased towards males (Murray et al., 2017). In particular, items related to masking and perfectionism were added to the AQ-10. The psychometric properties of this adapted AQ-10 will be reported at a later stage of the research project.

4.2.1.3 Hazard Perception Skill Instrument

The Hazard perception Skill instrument is a form self-report measurement, based on White et al. (2011). It contained 6 questions in which the participant must rate their skills on a scale of 1 to 7. The self-report measurement was used to determine how confident participants are in their driving skills compared to other drivers their age. This data can be used to make a comparison between autistic traits drivers and the control drivers, based on their average scores.

4.2.2 Driving task

For the driving task, a driving simulator was used. It consisted of a fixed base with a steering wheel, brake pedal and gas pedal. The environment was shown on three monitors, which also pictured the mirrors and speedometer. The data was recorded at 20 to 30 Hz. There were three drives. The first one consisted of a test drive without any hazards to get used to the simulator. The other two scenarios were both around 5 km long and one was situated in an urban environment, while the other one took place on a motorway. The environment was adapted to the Flemish road environment.

Table 1 Overview of included hazards

Hazard type	Precursor	Hazard
Behavioural Prediction hazards (BP)	Child visible next to the road, between parked cars.	The child steps onto the road.
	A cyclist riding on the side of the road.	The cyclist suddenly moves in front of the driver.
	A parked truck next to the road.	Suddenly leaves the parking spot in front of the driver.
Environmental Prediction hazards (EP)	Parked car next to the road.	A pedestrian appears in front of the car and walks onto the road.
	A blind curve.	Right after the curve is a broken-down truck with 4 blinkers on.
	A tall bus parked next to the road.	A taxi suddenly comes onto to the road in front of the bus.
Dividing and Focusing attention hazards (DF)	Cyclist on the other side of the road + parked car on the right side of the road.	Car suddenly leaves his parking spot, in front of the driver.
	Intersection where the participant has the right of way (4 arms). There are cars present on the left and right side of the intersection.	A car coming from the right, that doesn't have the right of way.
	Few people (4 -2 on the left and 2 on the right) are waiting to cross the road at a red light. The participant has a green light.	A pedestrian ignores the red light and crosses the road, coming from the right.

Both scenarios included some hazards. The three types of hazards: BP, EP and DF hazards, as classified by Crundall et al. (2012), were included. From every type, three hazards were selected. Table 1 shows the selected hazards and their precursors.

As reaction to the hazards, reaction time, time to collision and speed change were recorded. The reaction time was measured by the difference between the hazard onset and either the release of the gas or the brake press. The time to collision was calculated at the brake onset, using the current speed to determine the time until a collision with the hazard. This represents the risk of the following distance to the hazard. Third, speed change was measured by averaging the speed 100 meters before the hazard, in zones of 10 meter. The speed of the first zone was subtracted from the last zone to calculate the abruptness of the reaction.

Lastly, some general parameters such as collisions, full stops and SDLP were collected as well.

4.2.3 Post-questionnaire

The post-questionnaire contained 9 images from all hazards that were included during the driving simulation. The participant had to indicate whether he/she noticed the hazard, and how challenging it was to react to this hazard on a 5 point scale. This data will be used to give a better understanding of the participants reaction. The reaction will be monitored in the driving simulator.

4.2.4 Collected variables

The collected variables can be divided in objective and subjective data. The subjective data is the data that was collected in both the pre-questionnaire and the post-questionnaire. The pre-questionnaire contains their AQ score, gender, the number of years they have their license, their confidence presented by their HSPI score. The post-questionnaire contains their recognition rate of the hazards and their difficulty rating. The objective data consists of the parameters collected during the simulator drive, i.e. collisions, stops, standard deviation of the lateral position, reaction time, time to collision and speed changes.

Table 2 Overview of collected variables

Variable	Collection method	Possible scores
Autism Quotient (AQ)	Pre-questionnaire	0 - 22
Gender	Pre-questionnaire	0: Male; 1: Female
License	Pre-questionnaire	0: less than 2 years 1: more than 2 years
Hazard Perception Skill Instrument (HSPI)	Pre-questionnaire	0 - 42
Collisions	Driving simulator	/
Stops	Driving simulator	/
SDLP	Driving simulator	/
Reaction time	Driving simulator	/
Time to collision	Driving simulator	/
Speed changes	Driving simulator	/
Recognition	Post-questionnaire	0 - 3
Difficulty	Post-questionnaire	0 - 5

4.3 Data-analysis

Table 2 shows all collected variables that were used for a statistical analysis, which was carried out with IBM SPSS, version 28.0.1.0. There was one outlier that was excluded from the analysis. At the EP hazard, including the parked truck behind the blind curve, one participant did neither brake nor swerve to the left lane but managed to pass the truck on the right via the emergency lane without reducing speed.

Two different analyses were conducted. The first consisted of two-tailed independent samples t-tests to determine whether there was a significant difference between both groups. The independent variable was their group (control or autistic traits). First, the analysis was carried out for every driving parameter. After, the results of the questionnaires were also analysed. Furthermore, t-tests and ANOVA tests were conducted to determine the effect of the variables gender, HSPI score and license within both groups.

Second, ANOVA tests were used to establish any differences between the type of hazard within both groups separately. Again, all driving parameters and their self-reported skills were used as the dependent variable. The grouping variable in these tests was the type of hazard, using the same distinction as mentioned before.

5 Results

Table 3 displays a summary of the descriptive statistics of the two groups.

Table 3 Descriptive statistics

	Control group				Autistic traits group			
	Mean	SD	Min	Max	Mean	SD	Min	Max
HSPI	27,56	4,082	20	35	28,50	4,462	24	37
Collisions	1,31	0,793	0	3	1,42	1,165	0	3
Stops	1,87	1,025	0	3	2,08	1,084	0	4
SDLP	0,260	0,137	0,104	0,563	0,256	0,101	0,112	0,453
Reaction time	0,989	0,190	0,626	1,276	1,095	0,245	0,713	1,583
Time to collision	1,359	0,175	1,117	1,640	1,373	0,155	1,168	1,603
Speed change	7,099	1,297	4,556	8,837	6,581	1,498	3,957	9,099
Reaction time BP	0,892	0,328	0,556	1,650	0,940	0,349	0,478	1,639
Time to collision BP	1,735	0,196	1,504	2,105	1,680	0,236	1,239	2,181
Speed change BP	6,915	1,706	3,837	9,373	6,207	1,615	3,980	8,710
Recognition BP	2,75	0,447	2	3	2,92	0,289	2	3
Difficulty BP	2,927	0,626	2	4	2,875	0,795	1,667	4
Reaction time EP	0,855	0,307	0,350	1,417	0,951	0,428	0,605	2,206
Time to collision EP	1,067	0,281	0,483	1,651	1,129	0,226	0,825	1,474
Speed change EP	6,770	2,508	1,147	10,720	6,526	1,406	3,223	8,023
Recognition EP	2,37	0,619	1	3	2,42	0,669	1	3
Difficulty EP	2,760	0,735	1,5	4	2,708	0,311	2,333	3,333
Reaction time DF	1,221	0,427	0,305	1,683	1,394	0,426	0,522	1,908
Time to collision DF	1,275	0,301	0,758	1,688	1,310	0,309	0,735	1,700
Speed change DF	7,611	2,061	3,273	10,620	7,010	2,982	2,060	11,490
Recognition DF	2,75	0,447	2	3	3	0	3	3
Difficulty DF	2,333	0,599	1,5	3,333	2,306	0,611	1,333	3,333

5.1 Driving parameters

First, all driving parameters were analysed. This objective data was collected in the simulator drive and contains the parameters collisions, stops, standard deviation of the lateral position, reaction time, time to collision, and speed change. Furthermore, the last three parameters were also further divided into the three hazard types.

5.1.1 Between groups

First, the autistic trait group was compared to the control group. For collisions, there was no significant difference between both groups. There was also no group effect for full stops. For SDLP, there was again no significant difference. Overall, there were no significant differences in reaction time, time to collision or speed change between the control group and the autistic traits group.

Next, BP hazards are discussed. For BP hazards, there was no significant difference in reaction time between the control group and the autistic group. For the time to collision, there was, again, no effect of group. Going to speed change, no effect of group was found. Concerning the group effect for EP hazards, no effect was found for the reaction time to EP hazards. Going to time to collision, there was, again, no significant difference between both groups. For speed change, there was no significant effect of group. Lastly, DF hazards are discussed. There was no significant effect of group for the reaction time to DF hazards. For time to collision for DF hazards, there was no significant difference between groups. For speed change, there was again no effect of group.

5.1.2 Within control group

Second, the variables gender, license and confidence are analysed within the control group. The gender wise comparison showed that in the control group, females (mean = 2,57; SD = 0,535; min = 2; max = 3) made significantly more full stops ($t(14) = -2{,}949$; $p = 0{,}011$) than males (mean = 1,33; SD = 1; min = 0; max = 3). Furthermore, females (mean = 0,683; SD = 0,273; min = 0,350; max = 1,186) had a significantly smaller reaction time to EP hazards ($t(14) = 2{,}224$; $p = 0{,}043$) than males (mean = 0,988; SD = 0,273; min = 0,628; max = 1,417).

A comparison between drivers who had their license for over two years and drivers who didn't indicated that drivers who had their license for over two years (mean = 1,926; SD = 0,142; min = 1,735; max = 2,105), had a higher time to collision for BP hazards (t (14) = -4,688; p < 0,001) than drivers who had their license for under two years (mean = 1,620; SD = 0,116; min = 1,504; max = 1,916). A higher time to collision indicates a better following distance, so the experienced drivers performed better than the more novice drivers. The same effect of license that was found for BP hazards was not found for neither EP hazards (t (14) = 0,474; p = 0,643), nor DF hazards (t (14) = -1,065; p = 0,305).

For the comparison in confidence, the HSPI scores were used. In the control group, drivers who scored higher on the HSPI (mean = 0,172; SD = 0,057; min = 0,104; max = 0,256), and thus had more confidence in their skills, had a smaller SDLP (t (14) = 2,237; p = 0,042) than drivers with a lower HSPI score (mean = 0,312; SD = 0,146; min = 0,106; max = 0,563), indicating better lane-keeping skills.

5.1.3 Within autistic traits group

Third, the same analyses that were carried out for the variables gender, license and confidence were repeated for the autistic trait group. In this case, less effects were found. In the autistic group, there were differences between males and females. The comparison with confidence as an independent variable showed that drivers who had their license for over two years (mean = 1,57; SD = 0,976; min = 0; max = 3), made less full stops (t (10) = 2,274; p = 0,046) than drivers who had their license for under two years (mean = 2,80; SD = 0,837; min = 2; max = 4). Analyses for the variable confidence did not show any difference between more and less confident drivers.

5.2 Self-reported skills

Next, the self-reported skills were analysed. This subjective data was collected in the post-questionnaire and contains the parameters recognition and difficulty.

5.2.1 Between groups

First, any differences between the control group and the autistic trait group were analysed. For BP hazards, there was no effect of group for recognition or difficulty. There was also no significant difference between both groups for neither recognition nor difficulty of EP hazards. For DF hazards, the participants with autism traits had a significant higher recognition rate (t (15) = -2,236; p = 0,041). Table 3 indicates that every autism traits driver recognized every DF hazard. For difficulty of DF hazards, there was no difference between the control group and the autistic trait group.

5.2.2 Within control group

Next, the variables gender, license and confidence are analysed within the control group. The gender wise comparison showed that males (mean = 2,78; SD = 0,441; min = 2; max = 3) had a higher recognition rate of EP hazards (t (14) = 4,401; p < 0,001) than females (mean = 1,86; SD = 0,378; min = 1; max = 2).

For license, drivers who had their license for over two years (mean = 3; SD = 0; min = 3; max = 3), had a higher recognition rate for BP hazards (t (9) = -2,449; p = 0,037) than drivers who had their license for under two years (mean = 2,60; SD = 0,516; min = 2; max =3).

The comparison for confidence showed that drivers with a higher HSPI, so more confidence in their own skills, had a significant (t (9) = -2,449; p = 0,037) higher recognition rate (mean = 3; SD = 0; min = 3; max = 3) than drivers with a lower HSPI score (mean = 2,60; SD = 0,516; min = 2; max =3).

5.2.3 Within autistic traits group

The same variables were analysed within the autistic trait group. Here, no differences were found for gender, license or confidence.

Table 4 displays an overview of all found effects between both groups and within both groups.

Table 4 Overview of found effects

	Group effect	Variable comparison control group	Relation variable/driving	Variable comparison autistic traits group	Relation variable/ driving
Collisions	/	/	/	/	
Stops	/	Gender	Female → more full stops	License	>2 years license → less full stops
SDLP	/	HSPI	More confidence → smaller SDLP	/	
Reaction time BP	/	/	/	/	/
Time to collision BP	/	License	>2 years license → longer time to collision	/	/
Speed change BP	/	/	/	/	/
Recognition BP	/	HSPI License	More confidence → better recognition >2 years license → better recognition	/	/
Difficulty BP	/	/	/	/	/
Reaction time EP	/	Gender	Male → slower reaction time	/	/
Time to collision EP	/	/	/	/	/
Speed change EP	/	/	/	/	/
Recognition EP	/	Gender	Male → better recognition	/	/
Difficulty EP	/	/	/	/	/
Reaction time DF	/	/	/	/	/
Time to collision DF	/	/	/	/	/
Speed change DF	/	/	/	/	/
Recognition DF	Autistic traits group better	/	/	/	/
Difficulty DF	/	/	/	/	/

5.3 Reaction type

Next, this study aimed to investigate if there were differences in the type of reaction between the control group and the autistic traits group. Table 5 shows the type of reaction for both groups to the different types of hazards. For BP and EP hazards, no significant difference was found. For DF hazards, the autistic traits group was significantly more likely to use their brake instead of releasing the gas (t (26) = 2,079; p = 0,048).

Table 5 Reaction type

	Control group		Autistic traits group	
	Throttle release	Brake input	Throttle release	Brake input
BP hazards	91,67%	8,33%	97,22%	2,78%
EP hazards	85,42%	14,58%	88,89%	11,11%
DF hazards	79,17%	20,83%	63,89%	36,11%

5.4 Type of hazard

This study also aimed to see if there were differences between the three types of hazards within both groups. Table 6 shows that, in the control group, there was a significant difference in reaction time, time to collision and difficulty. Within the autistic trait group, there was a significant difference in reaction time and time to collision.

Table 6 ANOVA results for differences within groups

	Control group			Autistic traits group		
	F	df	Significance	F	df	Significance
Reaction time	5,079	2	0,010	4,952	2	0,013
Time to collision	26,930	2	<0,001	13,964	2	<0,001
Speed change	0,721	2	0,492	0,354 (Welch)	2	0,706
Difficulty	3,483	2	0,039	2,801	2	0,075

Table 7 indicates that, within the control group, the reaction time to DF hazards was significantly higher than the reaction time for BP hazards and the reaction time to EP hazards. Between BP hazards and EP hazards, there was no significant difference in reaction. Within the autistic traits group, the same results were found. The drivers had a significant slower reaction to DF hazards than to BP hazards and EP hazards. Again, there was no significant difference between BP hazards and EP hazards.

Table 7 Tukey HSD for reaction time differences within group

		Control group		Autistic traits group	
		Mean difference	Significance	Mean difference	Significance
BP	EP	0,037	0,955	-0,011	0,998
	DF	-0,330	0,033	-0,454	0,025
EP	BP	-0,037	0,955	0,011	0,998
	DF	-0,366	0,016	-0,443	0,029
DF	BP	0,330	0,033	0,453	0,025
	EP	0,366	0,016	0,443	0,029

The difference in time to collision was further investigated. Table 8 shows that within the control group, there was a higher time to collision for BP hazards than for EP hazards and DF hazards. Between EP hazards and DF hazards, there was no significant difference. The same distinction was found within the autistic trait group. The time to collision was higher for BP hazards than for EP hazards and DF hazards. Again, there was no difference between EP hazards and DF hazards.

Table 8 Tukey HSD for time to collision differences within group

		Control group		Autistic traits group	
		Mean difference	Significance	Mean difference	Significance
BP	EP	0,667	<0,001	0,550	<0,001
	DF	0,459	<0,001	0,370	0,004
EP	BP	-0,667	<0,001	-0,550	<0,001
	DF	-0,208	0,076	-0,181	0,219
DF	BP	-0,459	<0,001	-0,370	0,004
	EP	0,208	0,076	0,181	0,219

Lastly, the difference in difficulty within the control group was discussed. There was a significant difference in perceived difficulty between BP hazards and DF hazards. Between EP hazards and DF hazards, there was no significant difference. There was also no significant difference between BP hazards and EP hazards. Within the autistic traits group, there were no significant differences in difficulty rating between the three types of hazards. However, the significance follows the pattern as within the control group.

Table 9 Tukey HSD for difficulty differences within group

		Control group		Autistic traits group	
		Mean difference	Significance	Mean difference	Significance
BP	EP	0,167	0,754	0,167	0,780
	DF	0,594	0,036	0,570	0,069
EP	BP	-0,167	0,754	-0,167	0,780
	DF	0,427	0,168	0,403	0,248
DF	BP	-0,594	0,036	-0,570	0,069
	EP	-0,427	0,168	-0,403	0,248

6 Discussion

6.1 Group differences in self-reported skills

The results of the Hazard Perception Skill Instrument show that there is no difference between the autistic traits group and the control group. The autistic traits drivers think they are just as capable as the control drivers.

6.2 Group differences in driving performance related to hazards

This study did not find any differences between the control group and the autistic traits group for all variables, except for recognition of DF hazards. In the autistic traits group, all participants recognized all DF hazards. In the control group, the recognition rate was significantly lower. It is remarkable that the drivers with autistic traits, who had a higher recognition rate for DF hazards, used their brakes more often for the same type of hazard. This might indicate that the drivers with autistic traits prepared themselves for the hazard by already releasing the gas pedal before the onset of the hazard. On the other hand, within the autistic traits group, the reaction time for DF hazards was higher, indicating a slower reaction, which is contradictory if they were more prepared. Within the autistic trait group, the drivers who realised the throttle before the onset of the hazard, had a significant ($p = 0{,}003$) slower reaction time than those who released it after the onset. This might be caused by the fact that the drivers who released it beforehand, had a lower speed at the time of the hazard onset.

The results of this research contrast previous studies. In the study of Ross et al. (2019), the autistic drivers had a faster reaction to EP hazards and a slower reaction to DF hazards than the control group. However, for BP hazards, there was no difference either. The results of the current study are comparable to the study of Bishop et al. (2017), were there was no difference in reaction time to social hazards between the control group and the autistic group.

In the control group, there was an effect of the predictor HSPI for the variables SDLP and recognition of BP hazards. Drivers with more confidence in their hazard perception skills, had a smaller SDLP, indicating better lane-keeping skills. Furthermore, they also had a better recognition of BP hazards. It is important to note that, even though they estimated they had better skills, they did not perform better in terms of collisions, stops, reaction time, time to collision or speed changes. There was no significant difference in driving experience between the more and less confident drivers (Mann-Whitney $U = 48{,}00$; $z = 1{,}952$; $p = 0{,}056$). The lack of additional experience might explain why they do not perform better on these driving parameters. The only parameter on which more confident drivers performed better is the SDLP, which indicates they have a more stable lateral position. This contradicts Marottoli & Richardson (1998), who found no relation between confidence and driving performance in older drivers. For the predictor gender, there was a significant difference in stops, reaction time for EP hazards and recognition of EP hazards. This effect is remarkable, since males have a higher recognition rate for this type of hazards, but they have a slower reaction than females. In general, males are expected to have faster reaction times than females (Der & Deary, 2006; Shelton & Kumar, 2010; Jain et al., 2015). However, Silverman (2006) reported that the difference between males and females is decreasing, possibly due to more women participating in driving. According to Kosinski (2013) some other factors that can influence reaction time are age, relevance of stimulus to survival, direct or peripheral vision, practice and errors, fatigue, fasting, distraction, and intelligence. In the control group, there was no significant difference in the age distribution between males and females (Mann-Whitney $U = 23{,}00$; $z = -0{,}900$; $p = 0{,}408$), so this factor can be excluded from possible causes. The other factors were not measured in this study. For the predictor license, there were differences in time to collision for BP hazards and recognition of BP hazards. The more experienced drivers had a higher time to collision, indicating they practiced a safer following distance. Furthermore, they had a higher recognition rate. This effect was limited to BP hazards.

6.3 Differences in driving performance within group

Within both groups, the reaction time for DF hazards was higher than for BP hazards and EP hazards. This indicates that this type of hazard is more difficult than the other two. There are currently no other studies available that replicate or contradict this result. Most of the hazard perception studies apply the categorization of social and non-social hazards (Sheppard et al., 2009; Sheppard et al., 2016; Bishop, 2016; Bishop et al., 2017; Bednarz et al., 2021b; Bednarz et al., 2021c).

There was also a difference of time to collision within both groups. For BP hazards, the participants had a higher time to collision, indicating a larger following distance.

Lastly, in the control group, they found BP hazards more difficult than DF hazards. There was no reported difference between BP hazards and EP hazards or EP hazards and DF hazards. In the autistic traits group, there was no overall difference.

7 Practical implications

The study shows that autistic traits drivers are equally capable drivers as the control participants regarding hazard perception. There is no difference in reaction time, time to collision or speed for the three types of hazards. This contradicts the findings of Ross et al. (2019) in which autistic drivers performed better than the control drivers on EP hazards, equally on BP hazards and worse on DF hazards. Both groups had the slowest reaction times on DF hazards. For this type of hazards, the drivers had to divide their focus, which might have led to a slower detection of the actual hazard (Crundall et al., 2012). The participants had a higher time to collision for BP hazards. According to Horswill (2016a), it is beneficial to include hazard-perception training in the licensing process. In the United Kingdom, it reduced the drivers' crash rates by 11,3% in the year after obtaining their license. Furthermore, Horswill et al. (2013) found that hazard perception training is valuable, even for highly experienced drivers. Hazard perception skills can be successfully trained via simulator test (Liu et al., 2009; Cheng et al., 2011; Underwoord et al., 2011; Crundall et al., 2012; Meir et al., 2015; Yeung & Wong, 2015), video tests (Crundall et al., 2016; Johnston & Scialfa, 2016; Malone & Brünken, 2016; Ventsislavova et al., 2016, Gugliotta et al., 2017; Horswill et al., 2021), static image tests (Huestegge et al., 2010; Wetton et al., 2010; Scialfa et al., 2012; Scialfa et al., 2013; Feng et al., 2017) and commentary training (Isler et al., 2009; Crundall et al., 2010; Wetton et al., 2013; Castro et al., 2016; Young et al., 2017). For a review of results for the different types of hazard perception training, see Moran et al. (2019). Since both groups performed the worst on DF hazards, it might be useful to focus on this type of hazards in the training in general.

8 Limitations and future research

There are a few limitations. First, the study lacked participants with an official autism diagnosis. Only three of the drivers had an official diagnosis. The division is now based on their score on the adapted AQ test, however, this isn't an official test and there is no scientific threshold for this test. To be sure of the results, future studies should include more participants with an official autism diagnosis. Preferably, they should include autistic participants with a recent diagnosis. Most diagnostic tests are carried out in the childhood. Autism develops in a different way for every person, so only a recent diagnosis gives an accurate view of the severity of autism.

Second, the sample size of this study was limited to only 28 participants. To obtain significant results, a larger sample size is preferred. The descriptive results show small, however unsignificant, differences between the control group and the autistic trait group. A bigger sample might reveal more significant differences.

Third, the analysis in this research did not take the distance between the driver and the hazard at the onset time into account when comparing the different types of hazards. The distances were similar for every type, however, future research should include the distance as a covariate in the analysis.

Fourth, it could be valuable to include eye-movements in the study. Before a driver can react to hazard, it must be detected. Eye-tracking technology can record when a hazard is detected and how much time passes before the driver brakes. If the driver does not react to a certain hazard, it is a possibility he/she did not notice the hazard. This is known as the looked but failed to see principle. In this case, their reaction is invalid. The eye tracking can also be combined with the reaction time measurement to calculate how long it takes for drivers to lay their eyes on a certain precursor/hazard, and how long it takes them to react on this. This study aimed to use eye-tracking technology, but due to technological issues, this couldn't be included. There are already numerous studies which focus on the gaze movement in relation to hazard perception (Borowsky et al., 2010; Borowsky et al., 2012; Crundall et al., 2012; Tafaj et al., 2013; Mackenzie & Harris, 2014; Kahana-Levy et al., 2019; Malone & Brünken, 2019). According to Ting Chee et al. (2019), autistic drivers focused longer on the central visual field instead of scanning for potential hazards in their peripheral view. Furthermore, they focused less on social stimuli. This study used self-reporting to determine recognition and difficulty. The eye-tracking would have been a better method of determining if they recognized a hazard by calculating how long they focused on the hazard, but as mentioned before, eye-tracking could not be included in the research.

Lastly, more research should be carried out regarding the differences between BP, EP and DF hazards, since most studies focus on social or non-social hazards (Sheppard et al., 2009; Sheppard et al., 2016; Bishop, 2016; Bishop et al., 2017; Bednarz et al., 2021b; Bednarz et al., 2021c).

9 Conclusion

No significant differences in reaction time, time to collision and speed change were found between both groups, indicating that the autistic traits drivers are equally capable drivers as the control group regarding hazard perception. The HSPI questionnaire showed that drivers with autistic traits do not feel less capable as non-autistic drivers on hazard perception skills. Furthermore, the autistic traits group reported to have a significantly better recognition rate of DF hazards than the control group. In both groups, the reaction time towards DF hazards was significantly slower than for BP and EP hazards. Future research should include measurement of the eye-movement to include detection of the precursor and hazard as well. Furthermore, future research can elaborate more on different age groups and should include more drivers with an official autism diagnosis.

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Annexes

9.1 Adapted AQ test (Dutch)

De volgende vragen hebben niet specifiek betrekking op autorijden maar op alle situaties in je dagelijks leven. Geef aan in hoeverre je het eens bent met onderstaande stellingen. Gelieve één antwoord per vraag aan te duiden.

1) Ik vind het makkelijk 'om tussen de regels door te lezen' als iemand tegen me praat.
   a) Helemaal mee eens
   b) Enigszins mee eens
   c) Enigszins mee oneens
   d) Helemaal mee oneens

2) Ik richt mij meer op het totaalplaatje dan op de details.
   a) Helemaal mee eens
   b) Enigszins mee eens
   c) Enigszins mee oneens
   d) Helemaal mee oneens

3) Door naar iemands gezicht te kijken weet ik wat iemand denkt of voelt.
   a) Helemaal mee eens
   b) Enigszins mee eens
   c) Enigszins mee oneens
   d) Helemaal mee oneens

4) Meerdere dingen tegelijk doen gaat me gemakkelijk af.

a) Helemaal mee eens
b) Enigszins mee eens
c) Enigszins mee oneens
d) Helemaal mee oneens

5) Ik kijk niet graag in de ogen van de persoon waartegen ik aan het praten ben.
   a) Helemaal mee eens
   b) Enigszins mee eens
   c) Enigszins mee oneens
   d) Helemaal mee oneens

6) Ik vind het moeilijk om er achter te komen wat mensen willen.
   a) Helemaal mee eens
   b) Enigszins mee eens
   c) Enigszins mee oneens
   d) Helemaal mee oneens

7) Ik heb één of twee favoriet(e) onderwerp(en) waar ik vaak en veel over spreek.
   a) Helemaal mee eens
   b) Enigszins mee eens
   c) Enigszins mee oneens
   d) Helemaal mee oneens

8) Wanneer er onverwachte dingen gebeuren, vind het moeilijk om mijn emoties en mijn reacties op deze emoties onder controle te houden.
   a) Helemaal mee eens
   b) Enigszins mee eens
   c) Enigszins mee oneens
   d) Helemaal mee oneens

9) Ik merk het als mensen die naar me luisteren zich gaan vervelen.
   a) Helemaal mee eens
   b) Enigszins mee eens
   c) Enigszins mee oneens
   d) Helemaal mee oneens

10) Wanneer ik een regel moet overtreden vind ik het moeilijk om met deze situatie om te gaan.
   a) Helemaal mee eens
   b) Enigszins mee eens
   c) Enigszins mee oneens
   d) Helemaal mee oneens

11) Ik heb rituelen en stel repetitief gedrag.
   a) Helemaal mee eens
   b) Enigszins mee eens
   c) Enigszins mee oneens
   d) Helemaal mee oneens

12) Als ik een verhaal aan het lezen ben, vind ik het moeilijk om te achterhalen waarom de personages iets doen.
   a) Helemaal mee eens
   b) Enigszins mee eens
   c) Enigszins mee oneens
   d) Helemaal mee oneens

13) Nog voor een gesprek plaatsvindt, bereid ik mijn antwoorden en grapjes al voor.
    a) Helemaal mee eens
    b) Enigszins mee eens
    c) Enigszins mee oneens
    d) Helemaal mee oneens

14) Ik hoor vaak kleine geluidjes als anderen niets horen.
    a) Helemaal mee eens
    b) Enigszins mee eens
    c) Enigszins mee oneens
    d) Helemaal mee oneens

15) Ik heb de neiging om gebaren, uitdrukkingen of gedragingen van andere mensen na te doen tijdens sociale interacties.
    a) Helemaal mee eens
    b) Enigszins mee eens
    c) Enigszins mee oneens
    d) Helemaal mee oneens

16) Ik werk liever alleen dan met anderen en blijf vaak op m'n eentje.
    a) Helemaal mee eens
    b) Enigszins mee eens
    c) Enigszins mee oneens
    d) Helemaal mee oneens

17) Als ik onderbroken word, kan ik makkelijk verder gaan waar ik gebleven was.
    a) Helemaal mee eens
    b) Enigszins mee eens
    c) Enigszins mee oneens
    d) Helemaal mee oneens

18) Ik verzamel graag informatie over specifieke onderwerpen (bijvoorbeeld automerken, volgens, trainen, planten).
    a) Helemaal mee eens
    b) Enigszins mee eens
    c) Enigszins mee oneens
    d) Helemaal mee oneens

19) Tijdens sociale contacten verplicht ik mezelf om oogcontact te maken.
    a) Helemaal mee eens
    b) Enigszins mee eens
    c) Enigszins mee oneens
    d) Helemaal mee oneens

20) Ik gebruik een vlakke, monotone stem tijdens het communiceren die niet goed uitdrukt wat ik voel.
    a) Helemaal mee eens
    b) Enigszins mee eens
    c) Enigszins mee oneens
    d) Helemaal mee oneens

21) Ik ben te veel bezig met het helemaal perfect uitvoeren van een taak, waardoor ik mijn doelen niet altijd kan bereiken.
    a) Helemaal mee eens
    b) Enigszins mee eens
    c) Enigszins mee oneens

d) Helemaal mee oneens

22) Als ik mijn vooropgestelde niveau of doel niet behaal bij de uitvoering van een taak, kan ik hier overstuur van raken
a) Helemaal mee eens
b) Enigszins mee eens
c) Enigszins mee oneens
d) Helemaal mee oneens

9.2 Hazard Perception Skill Instrument (White et al., 2011)

Table 1
Hazard perception skill estimate items.

Item	Compared to a typical young driver, how skilful are you at. . .
1	Spotting hazards quickly?
2	Spotting hazards with enough time to react?
3	Spotting numerous hazards at a time?
4	Reacting to more than one potential hazard at a time?
5	Spotting hazards in heavy traffic?
6	Spotting hazards in light traffic?

Note: All items are rated on a scale from 1 ("much less") to 7 ("much more") with a mid point of 4 (the same)

9.3 Post-questionnaire (Dutch)

1. Heb je het volgende gevaar opgemerkt en/of gezien? (Een motorrijder die plotseling voor je de rijweg opreed)
   - □ Ja (ga naar vraag 2)
   - □ Nee (ga naar vraag 3)

2. Hoe moeilijk was dit gevaar voor jou? (Een motorrijder die plotseling voor je de rijweg opreed)
   - □ Heel moeilijk
   - □ Moeilijk
   - □ Niet moeilijk, niet gemakkelijk
   - □ Gemakkelijk
   - □ Heel gemakkelijk

3. Heb je het volgende gevaar opgemerkt en/of gezien? (Een auto die plotseling voor je de rijweg opreed).
   - □ Ja (ga naar vraag 4)
   - □ Nee (ga naar vraag 5)

4. Hoe moeilijk was dit gevaar voor jou? (Een auto die plotseling voor je de rijweg opreed)?
   - □ Heel moeilijk
   - □ Moeilijk
   - □ Niet moeilijk, niet gemakkelijk
   - □ Gemakkelijk
   - □ Heel gemakkelijk

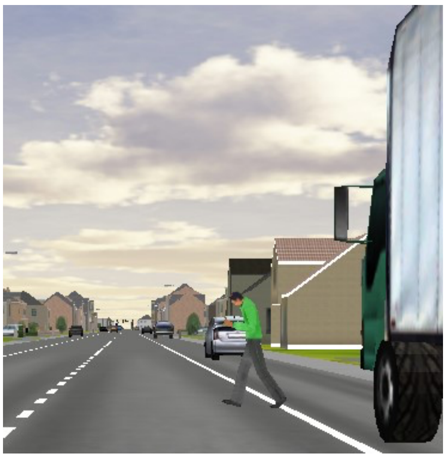
5. Heb je het volgende gevaar opgemerkt en/of gezien? (Een kind dat vlak voor je auto de weg op stapte)
   - □ Ja (ga naar vraag 6)
   - □ Nee (ga naar vraag 7)

6. Hoe moeilijk was dit gevaar voor jou? (Een kind dat vlak voor je auto de weg op stapte)
   - □ Heel moeilijk
   - □ Moeilijk
   - □ Niet moeilijk, niet gemakkelijk
   - □ Gemakkelijk
   - □ Heel gemakkelijk

7. Heb je het volgende gevaar opgemerkt en/of gezien? (Een auto die van rechts kwam vlak voor je het kruispunt opreed)
   - □ Ja (ga naar vraag 8)
   - □ Nee (ga naar vraag 9)

8. Hoe moeilijk was dit gevaar voor jou? (Een auto die van rechts kwam vlak voor je het kruispunt opreed)
    - □ Heel moeilijk
    - □ Moeilijk
    - □ Niet moeilijk, niet gemakkelijk
    - □ Gemakkelijk
    - □ Heel gemakkelijk

9. Heb je het volgende gevaar opgemerkt en/of gezien? (Een persoon met zijn gsm die voor jouw auto overstak van achter een geparkeerde auto)
    - □ Ja (ga naar vraag 10)
    - □ Nee (ga naar vraag 11)



10. Hoe moeilijk was dit gevaar voor jou? (Een persoon met zijn gsm die voor jouw auto overstak van achter een geparkeerde auto)
    - □ Heel moeilijk
    - □ Moeilijk
    - □ Niet moeilijk, niet gemakkelijk
    - □ Gemakkelijk

- ☐ Heel gemakkelijk

11. Heb je het volgende gevaar opgemerkt en/of gezien? (Een auto die plotseling van voor een bus tevoorschijn kwam en voor je de rijweg opreed)
    - ☐ Ja (ga naar vraag 12)
    - ☐ Nee (ga naar vraag 13)

12. Hoe moeilijk was dit gevaar voor jou? (Een auto die plotseling van voor een bus tevoorschijn kwam en voor je de rijweg opreed)
    - ☐ Heel moeilijk
    - ☐ Moeilijk
    - ☐ Niet moeilijk, niet gemakkelijk
    - ☐ Gemakkelijk
    - ☐ Heel gemakkelijk

13. Heb je het volgende gevaar opgemerkt en/of gezien? (Een geparkeerde vrachtwagen die plotseling voor je de rijweg opreed)
    - ☐ Ja (ga naar vraag 14)
    - ☐ Nee (ga naar vraag 15)

14. Hoe moeilijk was dit gevaar voor jou? (Een geparkeerde vrachtwagen die plotseling voor je de rijweg opreed)
    - ☐ Heel moeilijk
    - ☐ Moeilijk
    - ☐ Niet moeilijk, niet gemakkelijk
    - ☐ Gemakkelijk
    - ☐ Heel gemakkelijk

15. Heb je het volgende gevaar opgemerkt en/of gezien? (Een voetganger stak plots over terwijl hij rood licht had en jij groen licht)
    - ☐ Ja (ga naar vraag 16)
    - ☐ Nee (ga naar vraag 17)

16. Hoe moeilijk was dit gevaar voor jou? (Een voetganger stak plots over terwijl hij rood licht had en jij groen licht)
    - ☐ Heel moeilijk
    - ☐ Moeilijk
    - ☐ Niet moeilijk, niet gemakkelijk
    - ☐ Gemakkelijk
    - ☐ Heel gemakkelijk

17. Heb je het volgende gevaar opgemerkt en/of gezien? (Een vrachtwagen stond in een bocht in panne op de rechterrijstrook)
    - ☐ Ja (ga naar vraag 18)
    - ☐ Nee (einde vragenlijst)

18. Hoe moeilijk was dit gevaar voor jou? (Een vrachtwagen stond in een bocht in panne op de rechterrijstrook)
    - □ Heel moeilijk
    - □ Moeilijk
    - □ Niet moeilijk, niet gemakkelijk
    - □ Gemakkelijk
    - □ Heel gemakkelijk