Bachelor Thesis

Trust in Self-Driving Vehicles: A Persona Study

Jule Krüger
Psychology

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University of Twente
Department of Cognitive Psychology & Ergonomics
Psychology

Supervisors:

1. **Suzanne Vosslamber, MSc. (University of Twente, department CPE)**
2. **Dr. Matthijs Noordzij (University of Twente, department CPE)**

Abstract

Self-driving vehicles are already tested on the streets around the world and it is predicted that in ten years they will be available on the market. Still, many people look at this development quite sceptically. An important factor that contributes to a positive opinion towards new automated technology and thus self-driving cars is trust. To understand this trust better it is important to understand the factors that contribute to trust in self-driving vehicles. Because in the past individual differences in trust in automation could be found, the present study uses the Persona Technique to find out more about how trust in self-driving vehicles looks like and if individual differences can be found. Through ten interviews with questions based on the literature review different behavioural variables on which potential users of self-driving vehicles differ could be established. Three personas were found and elaborated. These three personas represent three levels of trust in self-driving vehicles, from low trust to high trust. Also, they differ in their technology opinion and use, their car use, experience and opinion, their opinion on self-driving cars and their trust characteristics. So, individual differences in potential users of self-driving cars could be found with which self-driving cars and promotion of these can be designed in the best way.

Samenvatting

Zelfrijdende voertuigen worden al op de hele wereld op straat getest en het wordt voorspeld dat zij over tien jaar op de market beschikbaar zijn. Maar nog steeds zijn er vele mensen die deze ontwikkeling sceptisch bekijken. Een belangrijke factoor die bijdraagt aan positieve meningen tegenover nieuwe geautomatiseerde technologie en dus zelfrijdende auto's is vertrouwen. Om dit vertrouwen beter te begrijpen is het belangrijk om de factoren te begrijpen die bijdragen aan vertrouwen in zelfrijdende auto's. Omdat in het verleden individuele verschillen in vertrouwen in automatie gevonden werden, wordt in deze studie de Persona Technique gebruikt om meer erover uit te vinden hoe het vertrouwen in zelfrijdende auto's eruitziet en of individuele verschillen gevonden kunnen werden. Door tien interviews met vragen die op de literatuur gebaseerd zijn konden verschillende gedragsvariabelen op welke potentiele gebruikers verschillen gevonden worden. Drie personas werden gevonden en uitgewerkt. Deze drie personas representeren drie levels van vertrouwen in zelfrijdende auto's, van laag vertrouwen tot hoog vertrouwen. Zij verschillen ook in hun gebruik van en mening over technologie, hun autogebruik, -ervaring en -mening, hun mening over zelfrijdende auto's en de karakteristieken van hun vertrouwen. Dus, individuele verschillen tussen potentiele gebruikers werden gevonden, met behulp van welke zelfrijdende auto's en hun promotie op de beste manier kunnen worden ontworpen.

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Introduction

In the past, self-driving cars were seen as something only possible in science fiction movies. Now, they are not that fictitious anymore and have become reality. There are different projects in which self-driving vehicles are being tested all around the world right now which shows that self-driving cars are on their way to the open market. The biggest current project is Google's Self-Driving Car Project which started in 2009 with the testing of self-driving technology in the United States (Google Self-Driving Car Project, n.d.), but the testing has also started in other countries. In Italy (VisLab, 2016), Japan (Gordon-Bloomfield, 2013), the UK (Burn-Callander, 2015), Germany (Degenhart, 2015) and the Netherlands (WEpods, 2016) self-driving cars are already a topic under investigation. In 2015, the US Secretary of Transportation stated that he is very optimistic to see driverless cars in use all over the world by 2025 (Hauser, 2015). Although this might seem unrealistic, one of the most influencing organizations on this subject, Google, is already pushing to bring self-driving cars to the market (PR Newswire, 2015). The Institute of Electrical and Electronics Engineers (IEEE) predicts that by 2040 75% of all vehicles on the road will be autonomous (IEEE, 2012).

In the present study, the focus lies on trust in self-driving cars as a factor that influences the acceptance people have towards self-driving cars, which individual differences exist in this trust and were they might come from. But first, an explanation is given about self-driving cars.

Self-Driving Cars

To give an overview on what self-driving vehicles are, some explanations are given in this section. The U.S. Department of Transportation has defined five levels of vehicle automation to create a universal classification that can be used to make clear which level of automation is talked about (NHTSA, 2013). The levels range from 0 to 4. On level 0 there is no automation, while on level 1 some automation is possible where either a steering or an acceleration/braking task can be controlled by the car. On level 2 a combination of automated features allows the car to take over a steering and acceleration/braking task at the same time. On level 3 and 4 the car generally does everything that the driver would have to do otherwise, the only difference being that on level 3 it is not able to do everything so that it tells the driver when he or she has to take back control. On level 4 in contrast, no control can be taken back by the driver. More detailed specifications of the levels are listed in Table 1. When talking about self-driving or autonomous cars or vehicles in this study, the third and fourth level of automation is meant because both include cars that are generally able to do all the driving tasks on their own and in level 3 only in some unknown situations the driver has to do the driving again.

Table 1

Five Levels of Vehicle Automation

Level	Description
Level 0 – No-Automation	- the driver controls all primary vehicle controls and is alone responsible for monitoring the road - the car itself cannot take control in any way - systems that provide only warnings or automated secondary controls (e.g. wipers, headlights, turn signals) are still considered "level 0"
Level 1 – Function-specific Automation	- one or more (independently operating) specific control functions allow that the driver or the vehicle can decide that the vehicle may take limited authority over a primary control (e.g. adaptive cruise control, electronic stability control or dynamic brake support) - it is <u>not</u> possible to have the hands off the steering wheel AND foot off pedal at the same time.
Level 2 – Combined Function Automation	- at least two primary control functions that are automated are designed to work together (e.g. adaptive cruise control + lane centring) - it is possible to have the hands off the steering wheel AND foot off pedal at the same time.
Level 3 – Limited Self-Driving Automation	- the driver can hand the full control of all functions to the vehicle under certain conditions - the driver then relies on the vehicle to monitor when it has to hand the control back to the driver (e.g. when it determines an upcoming construction area) - the driver does not have to constantly monitor the roadway and transition time between autonomous and manual driving is long enough
Level 4 – Full Self-Driving Automation	- the vehicle performs all driving functions and monitors the roadway conditions the whole time - destination or navigation input are given by the person starting the car ("the driver"), but he or she has to do nothing more than that and not even be available

Note. Adapted from http://www.nhtsa.gov/About+NHTSA/Press+Releases/U.S.+Department+of+Transportation+Releases+Policy+on+Automated+Vehicle+Development. Copyright 2013 by NHTSA.

As can be seen, self-driving or autonomous cars are vehicles that are able to drive on their own without needing a human driver. This is made possible through different sensors, including a GPS tracker so that the car knows where it is approximately and can drive to a given destination. Other sensors that are often used are radar sensors to determine where other cars are in front of, behind and next to the car, and a lidar sensor turning quickly on the roof that gives the information needed to build a three-dimensional picture of the surroundings including the edges of the road. Video cameras are used to read road signs and traffic lights and ultrasonic sensors may be used to detect things very close to the car when parking. A picture of a self-driving car including the different sensors can be found in Figure 1. It is important to note that a combination of the different sensors is necessary to ensure safe driving of the cars. The information of all the sensors is processed by a software in a central computer that combines the information. This software needs to be able to perceive the environment, plan what to do and control the vehicle (Thrun, 2010) while following the formal and informal traffic regulations, actions that a human driver also has to perform when driving a car so that no accidents happen when getting into contact with human drivers on the street.

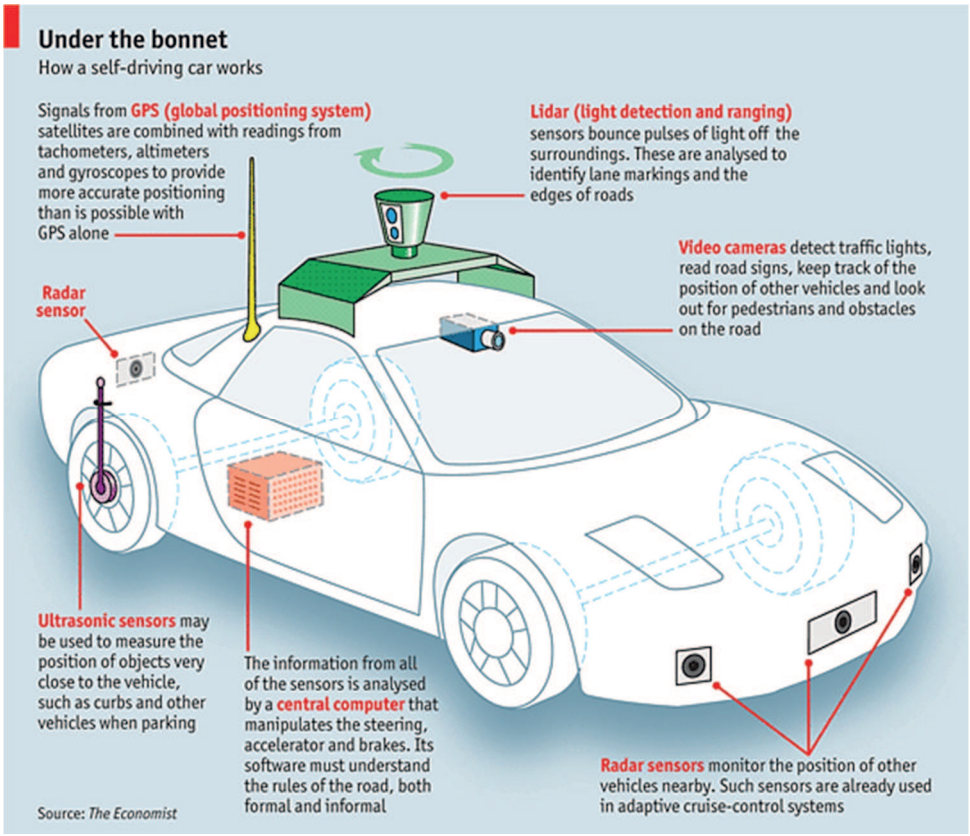


Figure 1. Different sensors used in self-driving cars including their positions in the car. Copyright 2013 by The Economist.

Trust in Self-Driving Cars

Self-driving cars are a technology of the (near) future. It has been shown in different domains that trust is important especially in the adoption of new technologies (Li, Hess & Valacich, 2008; Choi & Ji, 2015). So, in this study, trust in self-driving vehicles will be the subject for further research. According to Lee and See (2004) trust "can be defined as the attitude that an agent will help achieve an individual's goals in a situation characterized by uncertainty and vulnerability" (p. 51). The "agent" in this definition would in this case be a self-driving car, the goals could be to get somewhere safely and the uncertainty and vulnerability in this situation can be seen in the different concerns people still have with self-driving vehicles which are further elaborated below.

In diverse research it was found that trust has a big influence on the reliance on and acceptance of automation and smart technology (De Vries, Midden & Bouwhuis, 2003; Lee & Moray, 1992; 1994; Lee & See, 2004; Dzindolet, Peterson, Pomranky, Pierce & Beck, 2003; Khasawneh, Bowling, Jiang, Gramopadhye & Melloy, 2003; Uggirala, Gramopadhye, Melloy & Toler, 2004). Although trust between humans and machines has been researched in different domains, it still has to be "systematically studied in autonomous vehicle domain" (Choi & Ji, 2015, p. 692). To increase the understanding of trust in self-driving vehicles it was called for insights on factors that build trust (Leimeister, Ebner & Krcmar, 2005). In their research, Choi and Ji (2015) started looking for the factors that make people trust (or not trust) and accept (or not accept) autonomous vehicles. They used the technology acceptance model (TAM) and literature on the three dimensions of trust, perceived risk and the personality traits locus of control and sensation seeking to explain how acceptance of autonomous vehicles is influenced.

In Figure 2 the structural model that Choi and Ji (2015) assessed in their study can be seen. The focus in the present study lies on the left part of the model, namely trust and the three factors that were found to positively influence trust in self-driving cars. From those three factors, system transparency was defined as "the degree to which users can predict and understand the operating of autonomous vehicles" (Choi & Ji, 2015, p. 694), referring to the belief that a system is predictable and understandable. Technical competence is defined as how competent the user believes the autonomous car is and reflects the belief that a system performs tasks accurately and correctly. Situation management refers to the belief of the user that he or she can get back control when desired, so it refers to the belief that a system can give responsive and effective assistance. The three factors were found to significantly influence trust in self-driving cars in the proposed model, showing that the higher those factors are for a user, the higher the user's trust in self-driving vehicles is.

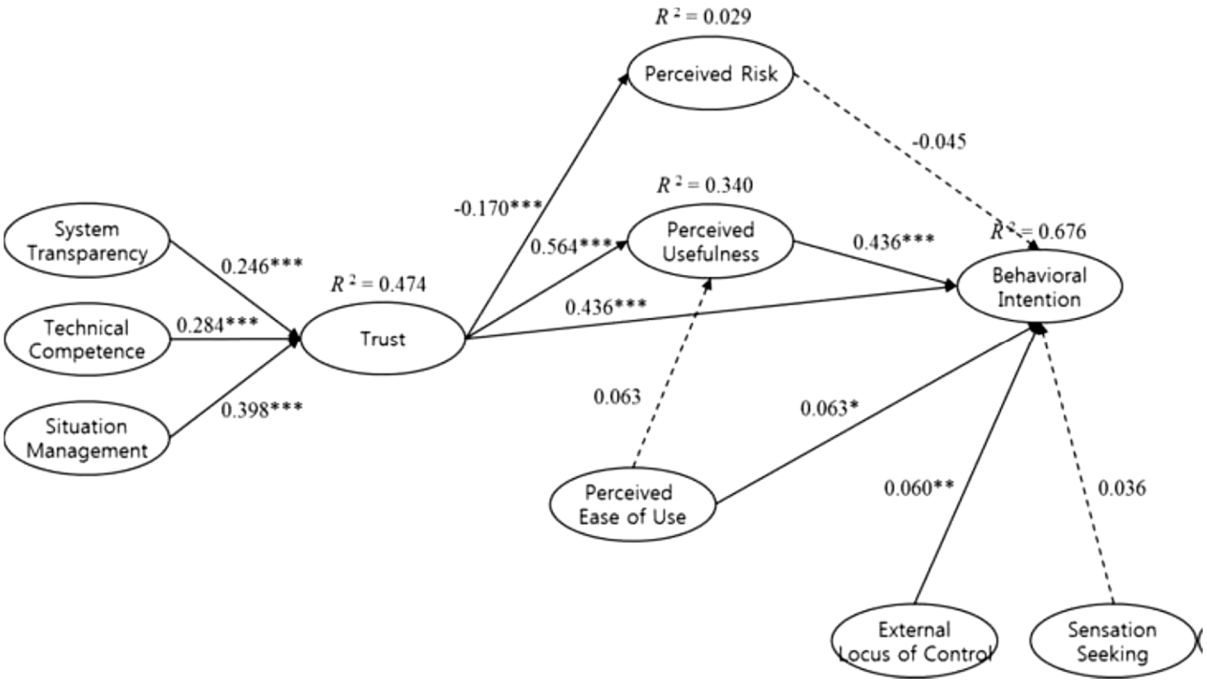


Figure 2. The structural model assessed by Choi and Ji (2015). *Note:* *$p < .05$. ** $p < .01$. ***$p < .001$. Copyright 2015 by Choi and Ji.

In the model it can further be seen that trust has a direct positive influence on the behavioural intention of using a self-driving car while it also has an influence on the behavioural intention that is mediated by the factor of perceived usefulness. When trust in self-driving cars is high, the perceived usefulness is also high, raising the behavioural intention of using a self-driving car (Choi & Ji, 2015). Trust seems to be a variable that has a big influence on the acceptance of or the intention to use a self-driving vehicle. To get a more complete picture on the aspects that influence the acceptance of and intention to use self-driving cars in the future, Choi and Ji (2015) suggest that their results should be expanded through the inclusion of other external variables. This shows that more research is needed on the factors influencing trust in self-driving vehicles and how and why they do so. The present study seeks to gather more information on trust in self-driving vehicles by finding out more about the existing individual differences concerning trust in self-driving vehicles. This includes the differences in the level of trust in self-driving cars, the different factors that contribute to trust and other characteristics of trust that might differ.

Different studies concerning trust in automation have suggested that individual differences in trust in self-driving vehicles do exist. The results of studies by Lee and Moray (1992, 1994) showed individual differences concerning automation use. In their studies, some participants were prone to use manual control, while some were prone to use automation, even though they all could easily change were they allocated the given tasks. Based on these findings,

Dzindolet, Peterson, Pomranky, Pierce and Beck (2003) suggested that more research is needed on individual differences in trust in automation. In addition, it became evident that a person's individual, organizational and cultural context has an influence on the development of trust (Lee & See, 2004). Merritt and Ilgen (2008) proposed that different users have different perceptions of machines and those perceptions mediate the relationship between real machine characteristics and trust. This shows a need for research in the area of individual differences in trust in automation.

While the focus of this study lies on individual differences in trust in self-driving cars, it also tries to link these differences to other individual differences concerning self-driving cars. One thing that differs greatly are people's opinions towards self-driving vehicles. In a study by KPGM (2013) in the U.S. for example it was found that most participants did not believe that a self-driving car could see and react more safely and efficiently than a human could, while in another study by Volvo in the Netherlands 78% of the respondents found that autonomous cars are safer in taking decisions than a human driver is and 86% of the respondents thought that self-driving cars would provide for less accidents (Van Loo, 2016). In the Continental Mobility Study 2013, a study on driving behaviour and mobility by the automotive supplier Continental, it was found that 61% of the participants from Germany and the United States thought of automated driving as something that could relieve them of the driving task in monotonous or stressful driving situations (Continental AG, 2015). Still, 52% said that automated driving rather scared them and 49.5% did not believe that it would ever function reliably. Both studies show that people differ in their opinions towards self-driving cars, which is included in the present study to find out more about how those differences in opinion might influence differences in trust. Another factor on which people differ is the experience they have with semi-autonomous features in car such as traffic jam assist and autonomous parking systems. In a study on opinions on self-driving cars, Youngs (2014) concluded that experience with semi-autonomous features helps to gradually increase the awareness of and trust in autonomous driving by consumers. The more the people get into contact with these features, the higher their trust in and opinion on self-driving cars might become. The individual differences in experience with semi-autonomous driving features are also included in the present study. People also differ on their relationship towards technology and cars in general. A study by Howard and Dai (2014) showed that an individual's travel behaviour and relationship to cars and technology in general affect their opinion about self-driving cars. This is why these individual differences are also included in the present study. So, for the differences in opinion towards self-driving cars, experience with semi-autonomous features and relationship towards technology and cars in

general, this study examines how these differences might influence the individual differences in trust.

The Present Study

As can be seen in the literature review on trust in self-driving vehicles presented above, trust is an important factor that influences whether people accept, rely on and intend to use self-driving cars or not. To get a more complete picture of the factors that contribute to the acceptance of and intention to use self-driving vehicles, more research on trust in self-driving cars is needed. In the study by Choi and Ji (2015) mentioned above, three factors (system transparency, technical competence and situation management) that influence trust in self-driving vehicles could already be determined. Because the authors suggest an expansion of their results including other external variables, it is chosen to search for other factors that might contribute to trust in self-driving vehicles and might also support their findings. A qualitative method is used for this because in qualitative research, people can give their own view by talking freely, allowing the research to obtain a deeper picture on what they think and why they think so. In the present study this might offer the opportunity for more insight in the reasons for different opinions on and factors influencing trust in self-driving vehicles.

On the basis of the literature review it is hypothesized that individual differences exist in trust in self-driving vehicles. The examination of these differences is used to gain a deeper insight in what trust in self-driving vehicles looks like. Furthermore, individual differences in opinion towards self-driving cars, experience with semi-autonomous features and relationship towards technology and cars in general are assumed to be linked to the individual differences in trust in self-driving vehicles. This study shall contribute to the understanding of how different factors, including the mentioned individual differences, might influence individual differences in trust in self-driving vehicles. The research question that will be answered in the present study is *"How do potential users differ in their trust in self-driving cars and the factors that influence this trust?"* In order to answer this question, the thesis will explore people's relationship with technology and cars and their experience with semi-autonomous features in cars, as well as what people think about self-driving cars, if they would trust them or not, and which factors affect their trust or distrust for which reasons. It will also be analysed if the factors found in the study by Choi and Ji (2015) can be supported and whether additional factors can be determined. To study the individual differences that can be found concerning trust in self-driving cars, the Personas Technique described in an article by Acuña, Castro and Juristo (2012) is used in the present study. Personas are created based on data gathered through interviews in order to answer the proposed research question.

Method

Respondents

Ten respondents (five male, five female) participated in the interview study that took place in April 2016. They were aged 20 to 25 (M = 21.8, SD = 1.6). Three respondents were German and seven were Dutch. They were studying psychology, international business administration, industrial design and mechanical engineering. The participants were selected based on convenience sampling at the University of Twente in Enschede. The inclusion criteria were to have a driver's license and to be a student. Students were chosen as respondents because self-driving cars will probably be available when they are done with studying and further educations so that they will be a part of the biggest target group for self-driving vehicles once the cars enter the market.

Materials

A semi-structured interview was held with all the participants following an interview scheme (Appendix B). These interviews were recorded using a recording application on a smartphone. In the interview, different topics were talked about through open questions that were supported by the interviewer asking more detailed questions about incomplete statements. The interview questions were formed based on the research goal and were tested in a pilot to make sure the interviewee understands everything. In accordance to the pilot interview, the order of some questions was changed. Also, a note was added to the questions asking for reasons for some opinions that, to avoid repetition, those were only to be asked when the respondents did not already mention the reasons on their own.

The interview was sectioned in five parts. After a short introduction, the demographics of the respondents were identified. In the second part, questions concerning the respondents' use of and opinion about technologies in their life were asked. This part was based on what Howard and Dai (2014) found out about people's relationship to technology in general, namely that it affects their opinion about self-driving cars. The third part of the interview included questions about the respondents' use of a car. These questions were asked based on findings by Howard and Dai (2014) that an individual's travel behaviour and relationship to cars affects their opinion about self-driving cars. After a short overview over levels 0 – 2 of automation, a short summary in bullet points was given to the respondents (Appendix C) to enable them to answer the questions concerning their experience with semi-autonomous features in cars. Then the respondents were asked if they had experience with cars that possessed some automation of driving. Because in level 0 no automation is present, they were asked if they had experience

with level 1 or 2 automation. The questions on experience with the lower levels of automation were based on the assumption made from the development in the J.D. Power U.S. Automotive Emerging Technologies Study (Youngs, 2014) that the experience with semi-autonomous features in cars helps increase the awareness of and trust in autonomous driving.

In the fourth part of the interview, more information on the remaining levels of automation (3 and 4) was given to the respondents to clarify what is meant by self-driving cars. A short summary of this information was given to the respondents on a piece of paper (Appendix C). Also, a short introduction to the different sensors used in self-driving cars was given, to ensure that every respondent had the same basic information on which their answers about self-driving cars would be based. This introduction was supported visually by an image of a car with the sensors (Appendix D) to give the respondents a better overview and clarify where the sensors are installed in a car.

In the fifth part, questions concerning the respondents' opinion on self-driving vehicles were asked, followed by questions concerning their trust so that individual differences could be spotted.

Procedure

After the pilot interview was held to test and practise the procedure and interview questions, potential respondents were contacted by the researcher personally and when interested in being an interviewee received a short message on the subject of the interview. An appointment was made with each respondent. The 10 interviews were conducted by one researcher individually and personally, either at the participant's home or at the university. The interviews were held in Dutch, a language all respondents and the interviewer were able to understand and speak. The average length of the interviews was 33 minutes (SD = 6 min.).

The semi-structured interview (Appendix B) held with the respondents consisted of five parts. Each part consisted of a number of open questions and questions that could be answered with yes or no were followed by "why"-questions. First, the respondents were welcomed and a short introduction to the study was given. The respondents signed an informed consent form (Appendix A). Also, they were asked for their age and study. The rest of the interview consisted of questions and explanations concerning technology, car use and opinions about and trust in self-driving cars. In the part of the interview about trust in self-driving cars, the respondents got the opportunity to talk about the things they found had an influence on their trust in self-driving vehicles without having to stick to pre-established response categories. After that, questions were asked to find if the three factors examined by Choi and Ji (2015) (system transparency,

technical competence and situation management) were also influential. In a conclusion, further questions of the respondents were settled and they were thanked for their participation.

Data Analysis

Activity 1 – 7 of the Personas Technique described in an article by Acuña, Castro and Juristo (2012) is used to analyse the data that was collected through the interviews. The remaining steps of the technique were beyond the scope of this study and were not carried out. *Activity 1: State Hypotheses* consisted of *Activity 1.1: Identify Possible Personas*, in which expectations about possible personas were stated, and *Activity 1.2: Hold Ethnographic Interviews*, in which the interviews were conducted and manually transcribed using Microsoft Office Word 2013. The hypotheses were based on the findings from the literature (section 'Introduction') and on the research question which can be found in the section 'The Present Study' in the introduction. These persona hypotheses can be found in Table 2.

Table 2

Persona Hypotheses

1. There are different personas representing different types of trust in self-driving vehicles.
2. Personas differ in their relationship towards technology in general and in their use of and experience with cars.
3. Personas differ in their opinions towards self-driving vehicles.
4. Personas differ in which aspects contribute to their trust in self-driving vehicles.
5. Differences in the different aspects contributing to trust are related to differences in trust in self-driving vehicles.

Activity 2: Identify Behavioural Variables consisted of *Activity 2.1: Synthesize Interview Responses* and *Activity 2.2: List Behavioural Variables.* In *Activity 2.1* the transcribed interviews were coded using Atlas.ti and behavioural variables were identified. This was done by looking at the interview questions, which were based on the literature review, to see which behavioural variables were possible. The behavioural variables were then listed in *Activity 2.2.* Then, by looking at the interviews, the different answers with regard to the questions on which the behavioural variables were based were structured in order to identify the ranges of the behavioural variables in *Activity 3.1.* A coding schema was constructed based on the behavioural variables on which the respondents differed (Appendix E).

In *Activtiy 3: Map Interview Subjects to Behavioural Variables* the two activities *Activtiy 3.1: Identify the Ranges of Behavioural Variable Values* and *Activtiy 3.2: Map Interview Subjects to Behavioural Variables* took place. In *Activity 3.1* a range of possible values for each behavioural variable from *2.2* was identified through looking at the answers the respondents gave and in *Activity 3.2* the respondents were grouped with respect to the ranges of the behavioural variables (Appendix F). This also yielded a list of percentages per variable range (Appendix G).

Activity 4: Identify Significant Behaviour Patterns consisted of the identification of groups of respondents that appeared in different variable ranges. A graphic (Appendix H) and a table (Appendix I) were assembled, including the percentage of respondents sharing the distinguishing variable range values.

In *Activity 5: Synthesize Characteristics and Relevant Goals* the characteristics, goals and the personality of the different personas were described which resulted in the personas grounding document. After that, in *Activity 6: Check for Redundancy and Completeness* the personas document was validated and in *Activity 7: Expand the Description of Attributes and Behaviours* a narrative for each persona including attitudes, personality, needs and problems of the personas was written.

Results

Identification of Behavioural Variables

In this section, the results from *Activity 2.1: Synthesize Interview Responses* and *Activity 2.2: List Behavioural Variables* are shown. From the coding of the interviews, 14 behavioural variables emerged on which users differ. These were split into two different sorts of variables. Variables 1 – 6 are the general background variables that are hypothesized to have an influence on trust in self-driving vehicles, but have no direct thematic connection to self-driving cars. They can be found in the section ‘Background variables’ in Table 3 and are based on the individual differences found in the literature review. They are used to characterise the personas more accurately and as stated in the introduction it is analysed whether they have an influence on individual differences in trust. Variables 7 – 14 are the variables that all have a direct thematic connection to self-driving cars. They can be found in the section ‘Self-driving cars variables’ in Table 4.

The variables 1, 2, 3, 4, 6, 7, 8 and 9 have a range of manifestations along a dimension with two extremes, as suggested by Castro, Acuna and Juristo (2008). For four other variables, 5, 10, 11 and 14, the extremes were not exactly opposed. For the two other concepts 12 and 13,

a number of topics emerged instead of ranges with opposing extremes. These topics represented different aspects within each variable. The respondents can be assigned to one or more of the topics because they all talked about at least one of them in the interviews.

Variable Ranges and Persona Patterns

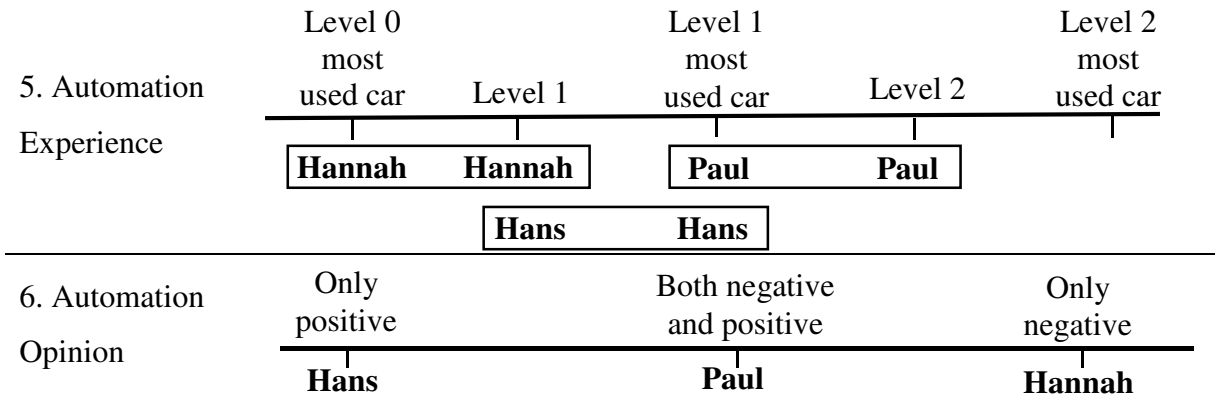
In this section the results of *Activity 3.1: Identify Ranges of Behavioural Variable Values, Activity 3.2: Map Interview Subjects to Behavioural Variables* and *Activity 4: Identify Significant Behaviour Patterns* are displayed. First, the results concerning the background variables are shown, followed by the results concerning the variables that stand in direct connection with self-driving vehicles. Each variable is displayed in a figure showing its range. For items 12 and 13 the salient topics are shown instead. Based on the respondents' mapping (Appendix F) the salient persona patterns were identified. These personas' positions regarding the ranges and topics are also displayed in the figure for each variable. Furthermore, based on the respondents' mapping a graphic (Appendix H) and a table (Appendix I) are assembled which shows the percentage of respondents within each persona that share each variable.

Background variables. In Table 4 the identified ranges of the background variables including their persona patterns can be seen. The results on these variables are described shortly below, split into the different personas.

Table 3

Variable Ranges and Persona Patterns of the Background Variables

Variable	Persona Pattern
1. Technology Use	Non-Standard — Standard **Paul** — **Hannah Hans**
2. Interest in New Technologies	High — Higher than Middle — Middle — Lower than Middle — Low **Paul** — **Hans** — **Hannah**
3. Frequency of Car Use	Often — Sometimes — Rarely **Hannah Hans** — **Paul**
4. Person Driving Mostly	Self — 50/50 — Other **Paul Hans** — **Hannah**



Persona Paul uses *non-standard technologies*, such as e-reader, tablet or smart watch, exemplifying his *high* interest in new technologies which are defined as recent or future (versions of) technologies. Because he does not possess a car, he *rarely* uses one. When he does, he most often drives *himself.* Persona Paul has much experience with semi-autonomous driving features. He has got a *level 1 automation in the car he uses most often* (e.g. cruises control) and already has some experience with *level 2 automation*. His opinion on the features is *both negative and positive* as he only likes them in particular situations.

Persona Hans only uses *standard technologies* such as smartphone, television and laptop. His interest in new technologies is *below middle*. He *sometimes* uses a car and drives *himself* most of the time. The car he drives most often has a *level 1 automation* which results in much experience with for example cruise control. His opinion on this sort of automation is *only positive* as he finds it very useful.

Persona Hannah only uses *standard technologies* and has a *low* interest in new technologies. She *sometimes* uses a car, but then she lets *others* drive most of the time. She does not have much experience with semi-autonomous driving features, only a little bit with *level 1 automation,* and the car she drives most often does not have any automation at all and is *level 0*. Her opinion towards this automation is *only negative* as she feels tense when she uses cruise control.

Self-driving cars variables. The identified variables, ranges and topics are displayed in Table 4. For the variables in which a range with two extremes was found only the utmost extremes are shown because they sufficiently illustrate the respective range. Then, the variables from Table 4 are defined and explained with aid of translated quotes from the interviews. The original Dutch quotes with their corresponding translation are displayed in Appendix K.

Table 4

Distinguishing Variables and Their Ranges or Topics for the Self-Driving Cars Variables

Category	Behavioural Variable	Range/Topics
Self-Driving Cars	7. Self-Driving Cars Opinion	Mainly Positive – Mainly Negative
	8. Use Intentions	Buying – No Use Intentions
	9. Situations in which to use Self-Driving Cars	Always – Never
	10. Imagined Feelings First Ride	Mainly Positive – Mainly Negative
Trust in Self-Driving Cars	11. Trust in Self-Driving Cars	Yes, in future when proven –No, but might change
	12. Trust Contributors	Functionality ǀ Knowledge ǀ Predictability ǀ Control Possibility ǀ Information Legal and Ethical Issues ǀ Transitional Stage
	13. Important Sort of Evidence for Technical Competence	Tests by Companies ǀ Other People Using Cars ǀ Using Car Oneself
	14. Levels of Distrust in Self-Driving Cars	Technology is never perfect, might always fail – When technology is developed and proven, there will be no problems

Variable 7: Self-driving cars opinion. In the answers on the questions concerning the respondents' opinions on self-driving cars different tendencies can be found. Persona Hannah states *more negative* arguments. Some of these negative points are that she would not like to give up control, technology might always go wrong and that when something goes wrong she would not know how to react. Persona Paul mentions *more positive* points. The main positive points are the efficiency and ease because you can do something else while you are on your way. The only negative aspect he mentions is that the fun to drive yourself gets lost. Persona Hans lies in the middle, stating *positive and negative* points. He thinks that self-driving cars might be better drivers than humans, but is still concerned about the safety and liability if something goes wrong, like when somebody hacks the car.

"I think that it really is an idea that would be ideal, especially for business people who do not need a driver." (Persona Paul, Respondent 1)

"All sensors, or, yeah, technologies that are in there, have to work simultaneously, and […] if for example the video camera suddenly fails, then that can be a very big problem." (Persona Hannah, Respondent 8)

"I think I have already let on that I from it, basically it works the, the system is quite accurate, but yeah, so, it is about the time that it goes wrong, say." (Persona Hans, Respondent 6)

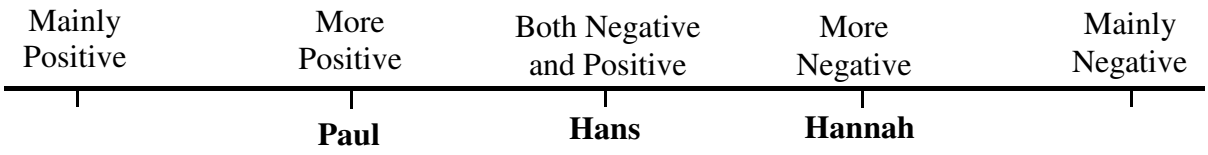


Figure 3. Range of 'Self-Driving Cars Opinion' with persona grouping.

Variable 8: Use intentions. There are differences concerning the intentions to use or buy a self-driving car in the future. Persona Hannah has *no intentions of using a self-driving car* in the future, justifying this by saying that she would never be able to stop thinking about the things that might go wrong with the technology. Persona Paul is certain to want to *buy or use self-driving cars* in the future because it would bring much ease to his life, not knowing yet if only using the cars through car-sharing might even be better than buying. Persona Hans links his choice if he will ever use a self-driving car to the *evidence that those cars are working as they should*.

"No, I could not imagine that, I don't think that that completely goes away. I have no knowledge of it, but I think that it always remains that oneself still has to do something." (Persona Hannah, Respondent 5)

"Yes, once it is more widespread, then it does seem interesting indeed to use a self-driving car." (Persona Paul, Respondent 9)

"Yes, actually, if the technology is entirely developed really, and it is proven, […] that it just becomes increasingly more safe, that increasingly more functions, and that it gets increasingly better, and if it is proven at the end, yes, then I will go over." (Persona Hans, Respondent 4)

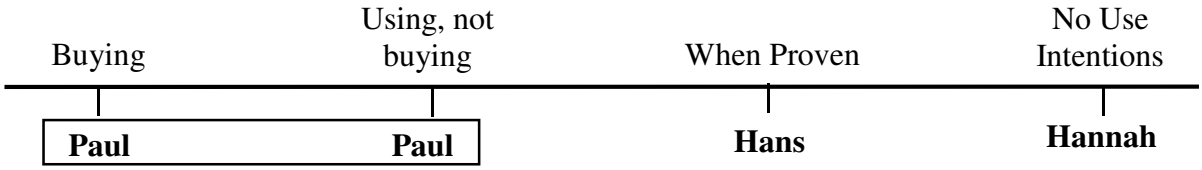


Figure 4. Range of 'Use Intentions' with persona grouping.

Variable 9: Situations in which to use self-driving cars. The respondents also differ in their opinion on when to use self-driving cars in the future. Persona Hannah would use self-driving cars in *very little situations*, for example on a test track, while persona Paul would use them in *many situations*. He would only not use self-driving cars but normal cars in situations in which he would want to drive for fun. Persona Hans would ride self-driving cars in *some situations* like on the highway but not in other situations such as driving in a busy city.

"Perhaps a test ride somewhere, or something. On a practice track. But no, I really can't imagine to just do that in a busy city." (Persona Hannah, Respondent 5)

"When the technology is very prior […] then I would probably try it […] some times, […] but I would not dare to […] then completely drive in a busy city." (Persona Hans, Respondent 4)

"Yes, well, to work is useful, for the rest it is also useful if you've been drinking that you for example don't have to yourself, […]. When you drive a bit for fun, let's say, then it seems nice for me to drive myself instead of that the car does it itself." (Persona Paul, Respondent 1)

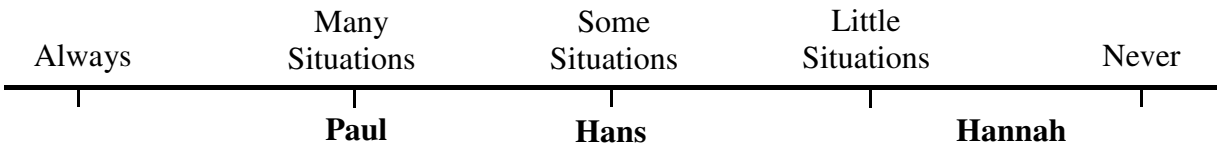


Figure 5. Range of 'Situations in which to use Self-Driving Cars' with persona grouping.

Variable 10: Imagined feelings first ride. The respondents differ in which feelings they imagine they would have on their first ride with a self-driving car. In the persona Hans, *more positive feelings* are imagined to be present during the first ride with a self-driving car, like surprise or happiness that he does not have to drive himself. Persona Hannah imagines *mainly negative feelings* to be present, like fear or powerlessness. In persona Paul *both sides* are imagined as being present.

"Very nice, very relaxed. […] I think that I will stay calm, I think that I trust it." (Persona Hans, Respondent 6)

"Well, first there is surprise because I probably sit in such a car for the first time, but I think that you get used to it very quickly and that it is then just, nearly just normal for you and that you then just find it easy." (Persona Paul, Respondent 1)

"So, the first few times I think when I look at myself, I would find it very strange, just, yeah, looking around in panic if everything works well." (Persona Hannah, Respondent 5)

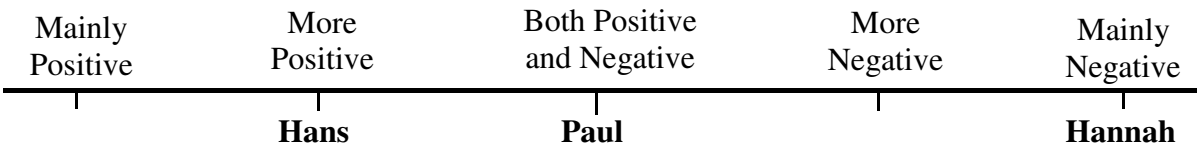


Figure 6. Range of 'Imagined Feelings First Ride' with persona grouping.

Variable 11: Trust in self-driving cars. The trust the respondents have in self-driving cars differ, but all of them say that they will only trust them when they are proven. The difference here lies in the words they use. Some say 'Yes, when they are proven in the future' and some say 'Not yet, but maybe if they are proven in the future'. The first of this statement implies that they will be proven in the future and then they will trust them, while the other statement shows that no real statement about trust will be made until the cars are proven. The third answer category is that no trust is present, but the possibility of this changing in the future is not completely excluded. Persona Paul says he *will trust self-driving cars in the future when they are proven*. Persona Hans says he does *not trust them yet, but this may change in the future if they are proven one time* and persona Hannah is *totally against trusting self-driving cars, but gives a sign that this could still change in the far future under different circumstances*. The question asked here was *"Do you think that you would trust the self-driving car?"*

"No." (Persona Hannah, Respondent 2)

"I think if it proves itself, then yes, I would." (Persona Paul, Respondent 9)

"Not at this moment. At this moment I would be really scared to drive, would I not dare to give away control, if the technology is really further developed, then I would, but, no, not yet." (Persona Hans, Respondent 4)

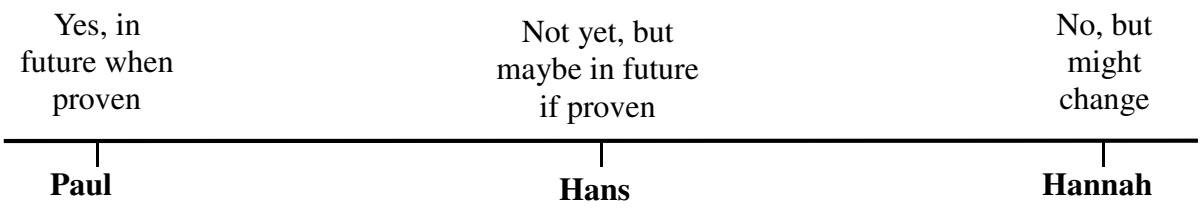


Figure 7. Range of 'Trust in Self-Driving Cars' with persona grouping.

Variable 12: Trust contributors. The respondents have different opinions on what is important for them to increase their trust in self-driving cars. The first thing that could increase the three personas' trust in self-driving cars is *functionality*, which is present if it can be shown that the car works the way it should and the technology does not fail. *Knowledge,* the second topic, is about the knowledge that people have about how such a car works, such as knowing the sensors that are used. *Predictability* is about if one can predict what the car does next. Those first three topics are important contributors to trust for all three personas. The *control possibility* in the car, which means that there is still a possibility to take back control once one gave it away, is an aspect that increases only persona Hannah's trust. Some *information on legal and ethical issues* like who is responsible when something goes wrong and what the car does in critical situations (for example when it has to decide between endangering the driver and endangering other people) is also important for persona Hannah. Persona Paul finds it important to have a *transitional stage* in which level 3 automatization where the driver can still take back control is used before going over to fully self-driving level 4 cars.

"I think I would have more trust in the car when there is just something, a pedal or something is still in there, because then I know that I, if I want to myself, can take back control. So, then you don't feel as powerless as if you can't, can't do anything." (Persona Hannah, Respondent 8)

"Once they can really prove that something works and for a longer time then it will probably work." (Persona Hans, Respondent 3)

"I think that I need a transition period for that, that I first have to be able to still intervene, before I give away control completely." (Persona Paul, Respondent 7)

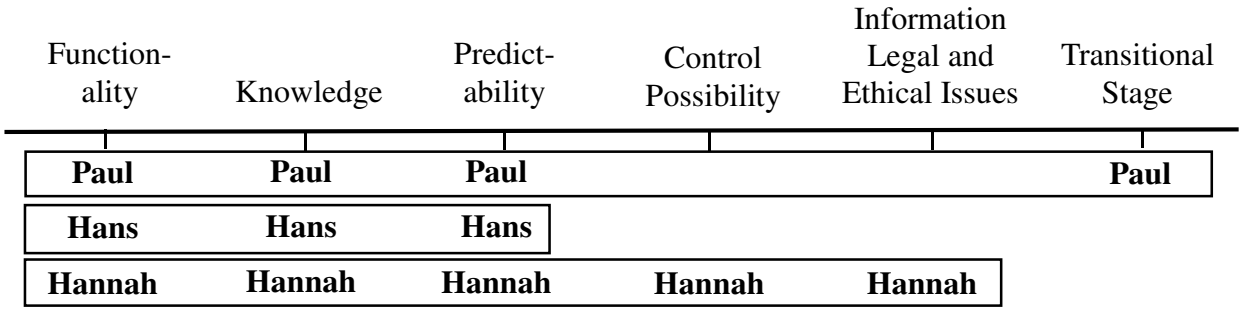


Figure 8. Topics of 'Trust Contributors' with persona grouping.

Variable 13: Important sort of evidence for functionality. The respondents differ in which evidence for the functionality of self-driving cars they find important. Persona Paul is

sure that *using self-driving cars himself* and collecting own experience with them is the best way to find out the functionality of those cars. Persona Hannah wants to look from further away through letting *reviews from other people* who used the cars give her evidence on whether self-driving cars are functioning reliably. Persona Hans is already convinced that the cars are working as they should after getting some *test statistics* from the car companies developing and testing self-driving cars.

"I think some experience. I think that especially. You also really don't know it now." (Persona Paul, Respondent 1)

"Maybe it […] first has to be used […] by many people and […] that I am more sure that nothing is going to happen and that this technology really works without mistakes." (Persona Hannah, Respondent 2)

"My trust, yeah, that is actually determined by if it can show through tests that it is far." (Persona Hans, Respondent 6)

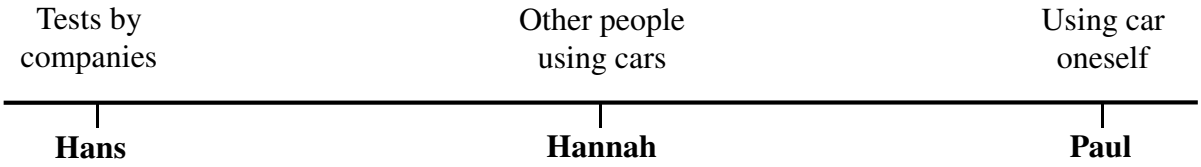


Figure 9. Topics of 'Important Sort of Evidence for Functionality' with persona grouping.

Variable 14: Levels of distrust in self-driving cars. The level of distrust in self-driving cars that the respondents have differ from each other. The biggest distrust lies in the remark that *no technology will ever function totally reliable and that there will always be malfunctions possible*. This distrust is present in persona Hannah. The next smaller level of distrust lies in the trust in that *the technology will work, but that other aspects are still problematic concerning self-driving cars*, like the legal and ethical issues that come with it, hacking and privacy issues, the acceptance in the society and cheating companies that tell something about the cars that might not be true. This level is present in persona Hans. The lowest level of distrust is the idea that *when the cars are proven at some time, there will be no problems at all*. This is present in persona Paul.

["Why wouldn't you buy a self-driving car?"] "Because very […] much technology is used and I know this from my smartphone or from my other technologies that also often a mistake happens." (Persona Hannah, Respondent 2)

"Well, indeed, the safety, can something like that be hacked, can my route be traced. […] Because in itself the technology itself would just work well, in my opinion, but, indeed, when now again sometime something happens." (Persona Hans, Respondent 6)

"Well, they first have to prove themselves that they actually don't ride up or something else and I think that that is especially important." (Persona Paul, Respondent 1)

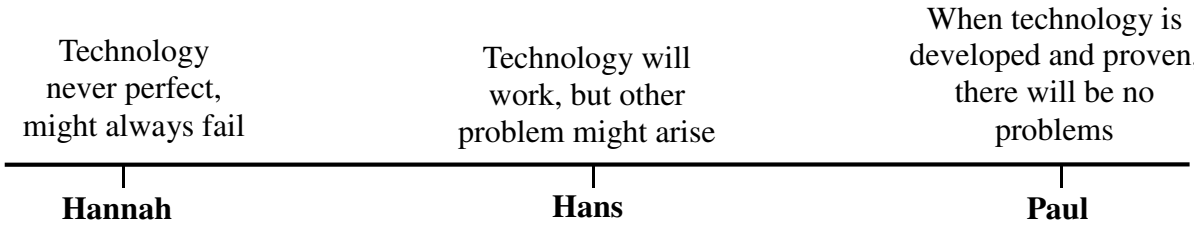


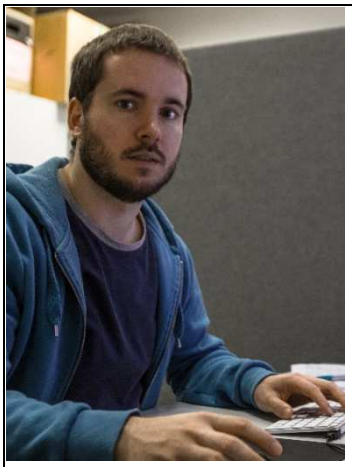
Figure 10. Range of 'Levels of Distrust in Self-Driving Cars' with persona grouping.

Personas' synthesis

In this section, the results from *Activity 5: Synthesize Characteristics and Relevant Goals* which is a detailed description of each identified persona including a persona's personality, behavioural characteristics and relevant goals. In Appendix J a short overview of the respondents' characteristics for each persona can be found.

The two personas Paul and Hans are more suited as target groups for selling self-driving vehicles, but the persona Hannah might also be convincible to use self-driving cars in the future when some convincing that the technology is really fail safe takes place.

The first persona, Paul, is based on 4 respondents. Their age ranges from 21 to 25 years (M = 22.75, SD = 1.48). One of them is female and three are male.



Paul

"Self-driving cars are the future – of course I will trust them once they are on the market"

Paul is 23 years old and an Industrial Design student. In his study, he works on designing new technologies and websites, but he also has a private interest in new technologies, where he likes to get information on new developments. When he has got some spare money, he tries to save some of it to be able to buy new gadgets for himself. In the morning, Paul goes to university by bike because he does not own a car. When he goes home on some weekends and in the holidays he is allowed to use his parents' car, which he likes to drive himself instead of being driven

by other people. The car he uses at home has a cruise control button, which he likes to use on the highway to be able to relax his feet. He very much likes such automation features because of the ease they give in specific situations. But sometimes he thinks that these features are redundant since he also likes to drive for fun now and then. Then he is happy to be able to shut down the automation features.

Paul has gotten into contact with self-driving cars through a project he has done at the university where they had to design a vacuum cleaner that coordinates his movements and cleans on his own. Since that project he cannot let go of the thought of self-driving cars on the streets. He tries to follow the developments that take place as good as possible and thinks about how these cars might be used in the future. He likes the idea of not owning a car anymore but sharing self-driving cars with other people. He believes that this would be very easy because the self-driving cars could deliver themselves to a household. The main positive aspects he sees in self-driving cars are the efficiency they might bring to his life because he can do other things in the car than driving. What he does not like so much is that the fun of driving will go missing, but he thinks that he would in general be able to trust self-driving cars when they will once be released to the market. He would trust self-driving cars in most of the situations he can think of, but would like to still have the possibility to drive for fun sometimes. When he thinks how his first ride in a self-driving car might feel like, he has mixed feelings, but thinks that eventually he will be able to enjoy the ride. He would like to first still have the possibility to take control over the car before completely going over to fully automated cars. He believes that this transitional stage might help him to grow accustomed to the new cars and learn to trust them while gathering some first-hand experience. This first-hand experience is the evidence he needs to be able to trust self-driving cars on their functionality completely. Also, getting information on how the cars work exactly is important for him to be able to trust them. He believes that once self-driving cars are available on the market and have been tested and proven enough, the technology will not go wrong and no other problems will arise. He is curious and excited about what the future holds for self-driving cars.

The second persona, Hans, is based on 3 respondents. Their ages range from 20 to 21 years ($M = 20.33$, $SD = 0.47$). Two of them are male and one is female.

Hans

"The technology in self-driving cars might at some time be trustable – but there are still other aspects that might cause problems"

Hans is 20 years old and studies International Business Administration. He lives with his parents in a city near the university and may sometimes use their car when the train or the busses ride at times that do not fit for him. The technology he uses is not the oldest but also not the newest one. He uses technologies as long as they still work before he buys something new. The most time when he sits in a car he drives himself and does not like being driven that much because when another person is driving he sometimes has difficulties placing his trust in him or her. His parents' car has cruise control which he likes using because it brings him some ease on highway routes.

He thinks positively about the fact that self-driving cars may increase his efficiency on a day, but still has some issues about probable hacking or legal issues as who is responsible when something goes wrong. Also, he thinks that the technology might be a better driver than some humans, but would still trust more in himself than in the technology. In the future, when self-driving cars are tested and proven to work well, he thinks that he has no antipathy to use or buy one. When this is the case, he would use such cars in most situations, but might not feel comfortable using them in high traffic areas in cities. When Hans thinks about the first time he will drive a self-driving car, he believes to have quite positive feelings like being surprised how good it works and being happy about once not having to drive. He thinks that if self-driving cars are ever proven by means of tests done by car companies that prove their functionality, he would be able to trust them. Evidence for functionality is in general important for him to increase his trust in self-driving cars and also some knowledge about how such cars function and how they react in particular situations. When technology in self-driving cars is proven some time, he will trust in them. But he still doubts that there will not be any other problems with self-driving cars like hacking, legal and ethical issues and non-acceptance in society.

The third persona, Hannah, is based on 3 respondents. Their ages range from 21 to 24 years (M = 22, SD = 1.41) and they are all female.

Hannah

"I cannot trust in technology – until now every technology I used failed at least once"

Hannah is 22 years old and a Psychology student. The technology she uses is not the newest. She thinks that technologies make her life easier, but is happy with the ones she has and has no desire to buy newer ones. Her boyfriend, who lives in another city, has a car that she may use some times, but most of the time he is driving when they go somewhere together. When being home she also uses her parents' car from time to time. In the cars she uses no driving automatization is present, but she used cruise control in one of her driving lessons, something she did not like very much because of having to rely on technologies.

When she first heard about self-driving cars, she could not imagine to ever use such a car. She has the feeling that she would always be afraid that a technology could fail, based on her experience that every technology fails sometimes. She has no intentions in using a self-driving car in the future when this can be avoided. When she thinks about the feelings she might have in a first ride with a self-driving car, she thinks of being afraid that something might happen and very tense because she knows that she cannot prevent anything from happening. She fears the powerlessness in the situation. Her distrust in self-driving cars lies in her deep distrust in technologies because she thinks that there is no 100% safety of them not failing. For her, it would be like hell to drive in a fully automated car. After many people will have tested self-driving cars and there will have been no message of something going wrong, someday she might test self-driving cars in which a switch to manual is still possible, but only if it is really necessary. What might change her negative opinion on self-driving cars and might support the growth of her trust in them are the reviews of other people who have driven the cars before. She does not exclude the possibility of changing her opinion on self-driving cars totally, but she does not see this happen in the near future. Evidence of the functionality of the cars might increase her trust, and also explanations of the technology showing what the car does when some component fails might do this. Also, she would have more trust in a self-driving car when she still had the possibility to take over control. She is also concerned with the question of who is guilty when something goes wrong and an accident happens. The 'driver'? The car company? Or the people who developed the

technology? Having a clear answer to this question might further increase her trust so that one day she might be able to ride in a self-driving car without panicking.

Discussion

Differences in trust in self-driving vehicles

This study should contribute to the understanding of trust in self-driving vehicles. To achieve this, in this study different types of trust in self-driving cars and the factors contributing to this trust were explored. Also, it was examined if some things as technology use, car use and opinion on self-driving cars are also factors that have to be taken into account when talking about trust in self-driving vehicles. All of these analyses were meant to answer the research question *"How do potential users differ in their trust in self-driving cars and the factors that influence this trust?"*. To get some information on the differences in trust in self-driving vehicles, ten interviews were held, transcribed and analysed according to the Personas Technique by Acuña, Castro and Juristo (2012). Three personas were formulated that should enable statements about users' trust in self-driving cars. They are stated in the following paragraph.

In this study three different user types (personas) were identified which have different levels of trust when it comes to self-driving vehicles. The persona with the highest trust, Paul, believes to be able to trust self-driving vehicles once they are fully developed. He is interested in new technologies and has a lot of experience with semi-autonomous driving features. What might contribute to his trust is a chance to test a self-driving car for functionality, knowledge of how it works and what it does in certain situations and also a transitional phase with level 3 automation before completely going over to level 4. His opinion about self-driving cars is positive and he intends to buy one and/or use them in many situations in the future. The persona with the middle level of trust, Hans, believes that the technology in the cars will work, but still other things might go wrong. He is not very interested in new technologies, but has a lot of experience with semi-autonomous driving features. Things that might contribute to his trust in self-driving cars are tests by the companies in which the cars' functionality is proven and more knowledge on how they work and what they do in certain situations. His opinion concerning self-driving cars is still mixed, but he intends to use them in at least some situations in the future, once they are proven completely. The persona with the lowest trust, Hannah, is at this point very sceptical when it comes to the technology in self-driving cars and believes that technology always fails. Still, she does not completely exclude trust to grow in the (far) future, which shows that she is not an anti-persona but only a very doubting one. She has low interest

in new technologies and not much experience with semi-autonomous driving features. Things that might increase her trust are other people testing self-driving cars to prove their functionality, more knowledge on how such cars work, what they do in particular situations and how liability and ethical issues are handled. In addition, it would be helpful if she had the possibility to take back control if desired. She has a quite negative opinion on self-driving cars and the only situation which she can imagine driving in such a car right now is on a test track.

All in all, different patterns could be established concerning users' relationship towards technology and cars in general, opinion on self-driving vehicles, trust in self-driving vehicles and the factors that influence this trust. These patters resulted in the identification of three personas Paul, Hans and Hannah.

Reflection on the literature

On basis of the results of the present study, different things can be discussed with regard to other literature. The findings concerning the individual differences established by means of the Persona technique are stated in this section.

In the present study, individual differences concerning the level of trust in self-driving cars could be found. These differences are partly based on users' perceptions of new technologies. While persona Paul believes that those technologies are a handy tool for making life easier, persona Hannah believes that new technologies are never perfect and at some point always fail. This supports and thus strengthens Merritt and Ilgen's (2008) findings that users' perceptions of machines mediate the relationship between real machine characteristics and trust. It might be interesting to further examine and expand these findings to see how users' perceptions of self-driving cars influence their trust.

Also, individual differences in the factors influencing the personas' trust were found. The three aspects that they all find important contributors to their trust are that the car is *functional*, that it is *predictable* in how it reacts in particular situations and that they *know how it works.* This supports the findings of Choi and Ji (2015). In their study, *functionality* is called 'technical competence' and was found as a factor influencing trust in self-driving cars. In the present study, this factor was split in three different sorts of evidence for this technical competence in which the personas differed, namely test results from car companies, own experience and reviews from other people. Therefore, a nuance could be added to this factor in Choi and Ji's model (Figure 11). A discussion of this can be found in the next paragraph. Another factor found by Choi and Ji (2015) is 'system transparency'. In the present study this can be found in the factors *knowledge* and *predictability* which are both aspects of Choi and

Ji's (2015) system transparency. Persona Hannah also finds it important to still have the *possibility to take back control* when she wants to, an aspect that can be found in Choi and Ji's factor situation management. As can be seen, all three factors found by Choi and Ji (2015) can be supported by the findings of this study, further supporting the assumption that those are important factors for trust in self-driving vehicles. However, there are also two contributors that can be added to Choi and Ji's model. For persona Hannah it is not only important to get information on how a self-driving car works but also on how *legal and ethical issues* such as the question who is responsible when something goes wrong are solved. This shows that people are also concerned about the legal and ethical level when thinking about trusting self-driving cars and not only on the technological level. Persona Paul says that a *transitional stage* in which cars with level 3 automation where a control possibility is present are used is an important step towards fully self-driving cars because one can get used to them without completely giving up control. This shows that it is important to also think about the transition from normal cars to fully-automated cars and how it might be possible to support the development of people's trust in that phase. In general, two new factors ('Regulations and Liability' and 'Transition Support') could be added to the existing model by Choi and Ji (2015). Anyhow, further support for these findings is needed, including an analysis of the model with the two new factors.

As already mentioned, concerning the factor *functionality*, there are some differences between the personas when it comes to how the functionality should be shown. Persona Paul

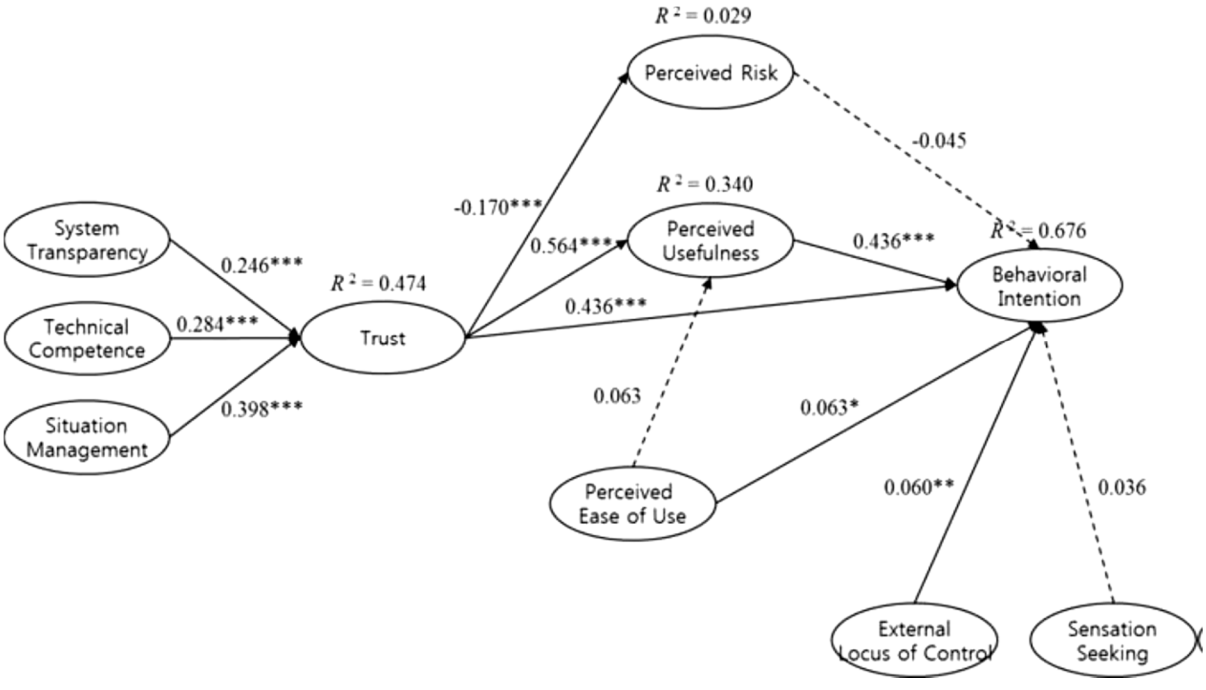


Figure 11. The structural model assessed by Choi and Ji (2015). *Note:* *$p < .05$. ** $p < .01$. ***$p < .001$. Copyright 2015 by Choi and Ji.

would like to test a self-driving car himself to prove the functionality, whereas persona Hans wants more test statistics from the car companies and persona Hannah wants to wait until many other people have used the cars and she can be sure that nothing goes wrong with the technology. These differences offer the possibility to place the three personas in the technology adoption lifecycle by Everett M. Rogers (2003), where five user groups are distinguished on basis of their innovativeness. *Innovators* are characterized as venturesome, which means that they like to try new things, and *early adopters* are seen as leading the majority towards a new innovation. Because persona Paul is interested in new technologies and would be the first to try a self-driving car to make sure that it works, those two groups seem fitting for him. The *early majority* is the first group to follow the early adopters. Persona Hans would first wait for the results of the companies concerning the released cars on the street, which shows that he would start using cars later than the *early adopters*, what makes him part of the *early majority*. The *late majority* is sceptical when it comes to new innovations and first has to be pressured by peers to adopt an innovation. All of its uncertainty has to be removed before it feels safe to adopt a new innovation. *Laggards* are suspicious of new innovations and have to be certain that something works before they adopt it. Persona Hannah would wait until many people have tested the cars and she can be sure that nothing goes wrong with the technology she does not trust yet. This shows that she fits into the two latest adopter categories. As can be seen, the three personas can be placed in the particular categories of the technology adoption lifecycle by Rogers (2003), showing that persona Paul will be the first and persona Hannah the last to adopt the new innovation. This gives the opportunity to address the three groups in the different ways that are fitting for their innovativeness.

Next to the individual differences concerning the trust in self-driving cars, also a pattern in the characteristics that were hypothesized to have an influence on the individual differences in trust was found. Firstly, opinions on self-driving cars and trust in self-driving cars seem to stay in a relation. The persona with the *most negative opinion about self-driving cars*, Hannah, also has the lowest trust in them, while the persona with the *most positive opinion about self-driving cars*, Paul, also has the highest trust in them. This shows that there might be a relationship between the opinion about and the trust in self-driving cars. Also, in the literature several concerns about self-driving cars could be found, which were software hacking and misuse (Kyriakidis, Happee & de Winter, 2015), liability and legal issues (Kyriakidis, Happee & de Winter, 2015; Howard & Dai, 2014), safety (Kyriakidis, Happee & de Winter, 2015; Casley, Jardim and Quartulli, 2013; KPMG, 2013), control, costs (Howard & Dai, 2014) and the missing pleasure when being driven in contrast to actively driving oneself (KPMG, 2013).

All of these concerns could also be found in the responses in the present study, supporting the assumption that these factors are important when it comes to opinions on self-driving cars. And, as can be seen in the fact that the most positive opinion stays in relation with the highest trust, these factors might indirectly also influence trust in self-driving cars. The influence of opinion about self-driving cars on trust in them might be an interesting subject for further analyses in future studies.

Secondly, also the intention to use self-driving cars in the future seems to stay in a relation with trust in self-driving cars. Persona Hannah, because of her low trust, has *no use intentions* at all for the future, while Paul, the persona with the highest trust, has the intention to use self-driving cars in *many situations* and maybe even *buy one in the future*. This shows that trust in self-driving cars might actually stay in relation with the intention to use such a car in the future. When looking back at the model proposed by Choi and Ji (2015; Figure 11, page 28) this connection can also be seen in there. In the model, 'Trust' has a positive influence on 'Behavioural Intentions'. Indeed, their finding that trust is an important factor when predicting the intentions to use a self-driving car in the future are supported by the present study, making this finding more powerful.

Thirdly, concerning relationship towards technology it was found that the persona with the highest trust in and the most positive opinion about self-driving cars, Paul, also has the *highest interest in (new) technologies*. This supports the findings by Howard and Dai (2014) which say that relationship towards technology affects opinions about self-driving cars. Further, this can be extended to the assumption that the interest in new technologies also influences the trust in self-driving cars. Somebody who is engaged in new technologies might generally have a higher level of trust in self-driving cars than somebody who is not. This could be the case because someone interested in technologies already got engaged in self-driving cars more than the other personas for example through reading about them. As knowledge about self-driving cars was found to be a factor contributing to trust in self-driving cars, the reason that the persona with the highest interest in new technologies has the highest trust in self-driving cars might be his higher knowledge about them. This shows that it is important to find out more about the relationship between knowledge about and trust in self-driving cars in future research.

Fourthly, another factor that could be found to show a pattern that matches the persona pattern are the individual differences concerning experiences with semi-autonomous driving features in cars. Hannah, the persona with the *least experience*, who also has the *most negative opinion* about those features, also has the lowest trust. Persona Paul, who has the *most experience* with those features, also has the highest trust. This shows that experience with semi-

autonomous driving features might have an influence on the level of trust one has in self-driving vehicles. This supports and thus strengthens Youngs's (2014) conclusion that experience with semi-autonomous features help to improve the awareness of and trust in autonomous driving by consumers. It might be interesting to further examine and expand these findings to see how exactly experience with semi-autonomous driving features influences users' trust in self-driving vehicles.

Strengths and limitations

The present study has some strengths that make it unique. The first strength is that in the literature review no other studies formulating personas for different types of trust in self-driving cars or even for self-driving cars in general could be found. This study might be the first one to do such a thing. Because trust is an important factor when it comes to acceptance of especially new technology (Li, Hess & Valacich, 2008; Choi & Ji, 2015), it is important to get more insight in what trust in self-driving cars looks like and which factors contribute to it (Leimeister, Ebner, & Krcmar, 2005). In the present study this was done through the creation of personas that showed individual differences in trust in self-driving cars and the underlying factors of this trust. A second strength is that in this study interviews were used. When using a qualitative method, people are able to speak freely about what comes to their mind, allowing the researcher to obtain a deeper picture on what they think and why they think so. This gave a more complete view on what goes on in people's heads, as can be shown in the fact that two factors could be added to Choi and Ji's (2015) model. This would not have been possible when the interviewees had only had the possibility to say whether the given factors were important for them of not. Also, the interviewer had the freedom to ask for more clarification when something was unclear. This was especially helpful when the interviewee gave an answer but no explanation or reasoning for it because then the interviewer was able to ask for this, leading to more concretely formulated answers highlighting the reasons for an opinion. The third strength of the present study is that the respondents came from different study backgrounds, some more and some less involved in new technologies. This gives a broader spectrum of knowledge about and awareness of new technologies in the respondents. If the students had come from only one study on the technical/non-technical spectrum, it might have been the case that all of them would have had the same interest in new technologies. Because of the possibly missing differences, a differentiation of three personas might not have been feasible, which shows the strength and importance of including students from different study backgrounds.

There are also some limitations in the present study. The first and most important limitation is that from the ten respondents only one had already gotten some experience with self-driving vehicles. All the other respondents only knew what they had heard, read or seen in videos about self-driving cars. It was tried to tackle the inequality of knowledge through giving some information on the different levels of automation in cars and on the sensors used in self-driving cars in the interview, but this does not provide the whole knowledge one needs, to know how one would for example feel when sitting in a self-driving car for the first time. To answer the question on how they would feel when sitting in such a car a short scenario was given in the interview in which the respondents had to imagine to sit in a self-driving car. So most of the answers concerning their trust in self-driving cars were based on their imagination and not on real experience. This might decrease the external validity (Calder, Phillips & Tybout, 1982) so that the findings might not be generalizable to the real situation when the users get into contact with real self-driving cars. It might be the case that then the users' opinions and trust would change completely so that the personas that were found would not be valid anymore. For a future study it might be an idea to include a small virtual reality section in the interview in which the interviewee can get a better grip on how it might feel to sit in a self-driving car. Even better would be a physical simulation of an autonomous vehicle such as the RRADS Platform (Baltodano, Sibi, Martelaro, Gowda, & Ju, 2015). This would make it easier for the users to see how they feel and might bring more externally valid results. The next step would then be to let them use real self-driving cars to get the most externally valid result. Another limitation that should be mentioned is that none of the interview subjects had a car for him- or herself. They all used cars that belonged to other people. This means for none of them a car was available all of the time so that none of them drove very often. People who own a car for themselves might have a different view on self-driving cars than people who do not, because they use and maybe need a car more often, so that they have a different view on cars in general. Other personas might have come forward with an inclusion of such people.

Recommendations

Self-driving cars will probably arrive on the market in the next ten to twenty years. Still, there is not much research on the factors that influence potential users' intention to use a self-driving vehicle in the future. As mentioned, one of the most important factors in this is trust. This study suggests that individual differences exist in the amount of trust people have in self-driving vehicles. These are based on different concerns people have, but also on characteristics such as their interest in technology or their experience with semi-autonomous driving features. The

different user types found suggest that more research is needed on which factors are important for which kind of person when it comes to trust in self-driving cars. One factor found is the knowledge people have about self-driving cars, but also on the legal and ethical issues that follow them. Research is needed on how giving potential users more information of this kind might improve their trust and thus also their intentions of using a self-driving car in the future. Another factor mentioned in the study, a transitional phase, calls for more research on how the transition between normal and self-driving cars should be realised to support the development of people's trust. In general, the two added factors need more research to clarify them. Because this was the first study to look at individual differences in trust in self-driving vehicles in more detail, more research is needed on this matter in general to support and expand the findings of this study.

Conclusion

In the present study three personas were identified that differ in their trust in self-driving vehicles. They represent three levels of trust in self-driving vehicles, from low trust to high trust. Different factors influencing this trust that could already be found by Choi and Ji (2015) and also two additional factors could be established. Moreover, the personas differ in the background characteristics that were hypothesized to have an influence on trust in self-driving vehicles. Their differences in opinion on self-driving cars seem to influence their trust in them and in accordance with Howard and Dai (2014), their technology opinion and use differs and seems to influence their trust in self-driving cars. Also, in support of Youngs's (2014) findings, the personas' experience with semi-autonomous driving features seems to have an influence on their trust. The results of this study show that there are individual differences when it comes to trust in self-driving vehicles, as already suggested by Dzindolet, Peterson, Pomranky, Pierce and Beck (2003). This insight is important when it comes to designing self-driving cars or marketing campaigns that want to increase people's awareness and trust in self-driving vehicles. Anyway, more research has to be done as the topic of trust in self-driving cars is still quite new in the scientific literature and to overcome the limitations of this study. The three personas found in this study are a starting point from which more research can be done so that an increasingly complete picture of how trust in self-driving vehicles looks like can be drawn.

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Appendix A: Informed Consent

Toestemmingsverklaringformulier (informed consent)

Titel onderzoek: Vertrouwen in zelfrijdende auto's
Verantwoordelijke onderzoeker: Jule Krüger

In te vullen door de deelnemer

Ik verklaar op een voor mij duidelijke wijze te zijn ingelicht over de aard, methode en doel van het onderzoek. Ik weet dat de gegevens en resultaten van het onderzoek alleen anoniem en vertrouwelijk aan derden bekend gemaakt zullen worden. Mijn vragen zijn naar tevredenheid beantwoord.

Ik begrijp dat audiomateriaal of bewerking daarvan uitsluitend voor analyse en/of wetenschappelijke presentaties zal worden gebruikt.

Ik stem geheel vrijwillig in met deelname aan dit onderzoek. Ik behoud me daarbij het recht voor om op elk moment zonder opgaaf van redenen mijn deelname aan dit onderzoek te beëindigen.

Naam deelnemer: ……

Datum: …… Handtekening deelnemer: …..……

In te vullen door de uitvoerende onderzoeker

Ik heb een mondelinge en schriftelijke toelichting gegeven op het onderzoek. Ik zal resterende vragen over het onderzoek naar vermogen beantwoorden. De deelnemer zal van een eventuele voortijdige beëindiging van deelname aan dit onderzoek geen nadelige gevolgen ondervinden.

Naam onderzoeker: ……

Datum: …… Handtekening onderzoeker: ...……..

Appendix B: Interview Schema

Introductie:

- Welkom
- Bedankt voor je deelname
- *Uitleggen onderzoek:*
    - Interview voor bacheloropdracht in Psychologie
    - Het gaat om vertrouwen in zelfrijdende auto's
    - Doel: uitvinden welke factoren bijdragen aan vertrouwen in zelfrijdende auto's
    - Vragen over verschillende onderwerpen
    - Duur interview ongeveer 45 minuten
- Het interview wordt opgenomen (audio), data wordt anoniem verwerkt
- *Tekenen Informed Consent* (zie laatste pagina)
- Zijn er op dit moment nog vragen?

Demografische vragen:

- Geslacht
- Leeftijd
- Opleiding

Vragen technologieën:

- Wij beginnen nu met sommige vragen over jouw gebruik van technologieën.
- Welke technologieën gebruik je? *(als geen antwoord weet:* Je kunt hierbij bijv. aan gereedschappen in je keuken denken, aan dingen in je woonkamer zoals de tv, aan dingen die je altijd bij je hebt, zoals je smartphone/smartband en ook aan dingen met welke je werkt, zoals een computer of laptop)
    - Waarvoor gebruik je technologieën meestal?
    - Hoe vaak, denk je, gebruik je deze dingen? (*als niet meer weet over welke dingen verteld even helpen en sommige dingen optellen die genoemd)*
- Wat vind je in het algemeen van technologieën?
- Waarvoor vind je technologieën handig? (*als nog niet verteld onder "Waarvoor gebruik je technologieën?")*
    - Waarvoor vindt je technologieën niet handig?
    - Welke aspecten van technologieën vindt je niet mooi?
- Zou je van jezelf zeggen, dat je altijd de nieuwste technologieën wilt hebben?
    - Hoezo, denk je, is dat zo?

Vragen rijgedrag:

- Nu heb ik sommige vragen over je rijgedrag met betrekking tot normale auto's.
- Hoe vaak gebruik je een auto? *(mag allebei vertellen, zelf rijden en meerijden)*
    - Rijd je vaker zelf of vaker met iemand mee?
- Hoe lang ben je per week gemiddeld met een auto onderweg?
- Is de auto, welke je meestal gebruikt, van jezelf of van iemand anders?
- Voor welke reden gebruik je een auto meestal?
    - Welke reden het vaakste?
- Als je een auto zou gaan kopen, wat vind je aan die auto dan belangrijk? *(als niet weet: kunt denken aan bijvoorbeeld prijs, grootte, comfort, snelheid,…)*

- Auto's kunnen worden ingedeeld in 5 levels van automatisatie:

    - Op het laagste level, level 0, bestaan er helemaal geen automatisatie. De bestuurder heeft controle over alle belangrijke bedieningspanelen en is zelf verantwoordelijk om te kijken wat op de straat gebeurd. Systemen die alleen waarschuwingen weergeven en dus zelf niets doen worden ook als level 0 gezien.
    - Op level 1 bestaat er een automatisering van een of meer functies, die echter geheel onafhankelijk van elkaar werken. De bestuurder mag beslissen, of hij door een of meer van deze functies een deel van de controle aan de auto overlaat. Hierbij is het niet mogelijk om tegelijkertijd zowel de handen van het stuur EN de voeten van de pedalen te nemen. Adaptive cruise control of remondersteuning zijn voorbeelden hiervoor.
    - Op level 2 is het zo, dat twee of meer van de controlefuncties die onder level 1 bedoeld werden nu ontworpen zijn om samen te werken. Hierbij is het mogelijk om tegelijkertijd zowel de handen van het stuur EN de voeten van de pedalen te nemen. Een voorbeeld is een combinatie van adaptive cruise control en baancentrering.
    - *Lijstje met informatie over levels van automatisatie geven (level 0-2)*
    - Heb je hier nog vragen over?
- Op basis, van wat ik net verteld heb, ben je al een auto gereden, die level 1 of 2 automatisatie had?
    - *Als ja:*
        - Welke?
        - Wat vond je daarvan?
    - *Als nee:*
        - Wat denk je, zou je daarvan vinden?
    - In de auto, die je meestal gebruikt, zijn er ook welke van deze slimme "hulpmiddelen" die onder level 1 of 2 vallen?
        - Welke?

Informatie zelfrijdende auto's:

- De minister voor transportatie van de Verenigde Staten heeft vorig jaar gezegd, dat 2025 zelfrijdende auto's op de hele wereld gebruikt gaan worden. Ook de Nederlandse overheid heeft de ambitie om de ontwikkeling van zelfrijdende auto's aan te leiden en Nederland voor te bereiden op de implementatie van de zelfrijdende auto's.
- Ik heb je net al level 0, 1 en 2 uitgelegd. Volledig zelfrijdende auto's zijn auto's op level 4, maar wij bedoelen in dit onderzoek ook auto's van level 3.
    - Op level 3 is het de bedoeling, dat de bestuurder de volledige controle van alle functies die belangrijk zijn voor het veilige rijden aan de auto kan overhandigen. De auto kan dan laten zien, als hij de controle weer terug wil geven, bijvoorbeeld bij een bouwplaats op de snelweg of een andere situatie die hij niet kent. De bestuurder moet hierbij niet de hele tijd op straat kijken, maar het bestaat nog steeds de mogelijkheid om de controle weer over te nemen. Op dit level zijn bijvoorbeeld de auto's, die van Google in de VS getest worden.
    - Op level 4 doet de auto alles, was anders de bestuurder zou moeten doen. De mens die de auto start mag een plaats van bestemming aangeven, maar moet daarna niet meer in de auto aanwezig zijn.
    - *Andere kant met lijstje over levels van automatisatie laten zien (level 3-4)*
- Heb je hier nog vragen over?

- Om duidelijk te maken, hoe deze zelfrijdende auto's werken, ga ik dit even aan je uitleggen.
    - *Plaatje zelfrijdende auto met sensoren laten zien (zie volgende pagina)* -> *beschrijven wat sensoren doen*
    - Samenwerking van sensoren belangrijk, een sensor alleen niet voldoende
- Heb je hier nog vragen over?

<u>Vragen zelfrijdende auto's:</u>

- De volgende vragen gaan nu over zelfrijdende auto's.
- Heb je al ervaring gemaakt met zelfrijdende auto's die dus een level 3 of 4 automatisering hebben?
- Op basis van wat ik je net over zelfrijdende auto's verteld heb, wat is je algemene mening over zelfrijdende auto's?
    - Wat bevalt je aan zelfrijdende auto's op basis van wat je tot nu over zij weet?
        - *(als nog geen reden gegeven)* Waarom?
    - Wat bevalt je niet aan zelfrijdende auto's op basis van wat je tot nu over zij weet?
        - *(als nog geen reden gegeven)* Waarom?
    - Zou je je voor kunnen stellen in de toekomst een zelfrijdende auto te gebruiken of zelfs te kopen?
        - *(als nog geen reden gegeven)* Waarom?
    - Op basis van wat ik je over zelfrijdende auto's verteld heb, in welke situaties zou je graag een zelfrijdende auto willen gebruiken?
        - *(als nog geen reden gegeven)* Waarom?
    - Wanneer zou je liever geen zelfrijdende auto willen gebruiken?
        - *(als nog geen reden gegeven)* Waarom?
- Op basis van wat ik je net over zelfrijdende auto's verteld heb, denk nu eraan, dat je in een zelfrijdende auto zit die je van Enschede naar Almelo brengt. Op de weg rijd je door de stad en op de snelweg. Je hebt geen mogelijkheid om de auto te controleren, omdat er noch een stuur, noch pedalen in zitten.
    - Wat denk je ben je in de auto aan het doen?
    - Wat denk je, welke gevoelens je hierbij zou kunnen hebben?
    - Denk je, dat je vertrouwen in de zelfrijdende auto zou hebben?
        - *Als geen vertrouwen:*
            - Waarop baseer je dit wantrouwen?
            - Wat moet er gebeuren, dat je wel vertrouwen in deze soort auto hebt?
            - Hoe komt dat?
        - *Als wel vertrouwen:*
            - Waarop baseer je dit vertrouwen?
            - Wat moet er gebeuren, dat je vertrouwen in deze soort auto nog verhoogd wordt?
            - Hoe komt dat?
    - Welke aspecten denk je hebben invloed op jouw vertrouwen in de zelfrijdende auto?
        - *Als de proefpersoon geen antwoord weet of deze factoren niet genoemd zijn, nagaan, of deze factoren belangrijk zijn of niet:*
        - Op basis van wat ik over de sensoren en levels van automatisatie aan je heb uitgelegd en je voorkennis, heb je het gevoel, dat je begrijpt hoe een zelfrijdende auto werkt?

        - Denk je, dat dit begrijpen/niet begrijpen van de werking van zelfrijdende auto's invloed heeft op je vertrouwen in deze? *(System Transparency)*
        - Zou je vertrouwen hoger zijn, als je zou kunnen voorspellen wat precies de auto in een bepaalde situatie doet? *(System Transparency)*
    - Denk je, dat een zelfrijdende auto zijn opdrachten juist volbrengt?
        - Denk je, dat deze mening van jouw over zelfrijdende auto's jouw vertrouwen beïnvloedt? *(Technical Competence)*
    - Denk je, dat je meer vertrouwen hebt in auto's van level 3, waar je de controle over de auto terug kunt nemen, dan in auto's met level 4 automatie, waar je de controle niet meer terug kunt nemen? *(Situation Management)*

Afsluiting:

- Klaar met interview
- Bedankt voor tijd
- Nog vragen/opmerkingen?

Appendix C: List of Levels of Automation

Level 0:

- helemaal geen automatisatie
- de bestuurder heeft controle over alle belangrijke bedieningspanelen
- de bestuurder is zelf verantwoordelijk om te kijken wat op de straat gebeurd
- systemen die alleen waarschuwingen weergeven en dus zelf niets doen worden ook als level 0 gezien.

Level 1:

- automatisering van een of meer functies, die echter geheel onafhankelijk van elkaar werken
- de bestuurder mag beslissen, of hij door een of meer van deze functies een deel van de controle aan de auto overlaat
- het is niet mogelijk om tegelijkertijd zowel de handen van het stuur EN de voeten van de pedalen te nemen
- Voorbeelden: Adaptive cruise control of remondersteuning

Level 2:

- twee of meer van de controlefuncties die onder level 1 bedoeld werden zijn ontworpen om samen te werken
- het is mogelijk om tegelijkertijd zowel de handen van het stuur EN de voeten van de pedalen te nemen
- Voorbeeld: combinatie van adaptive cruise control en baancentrering

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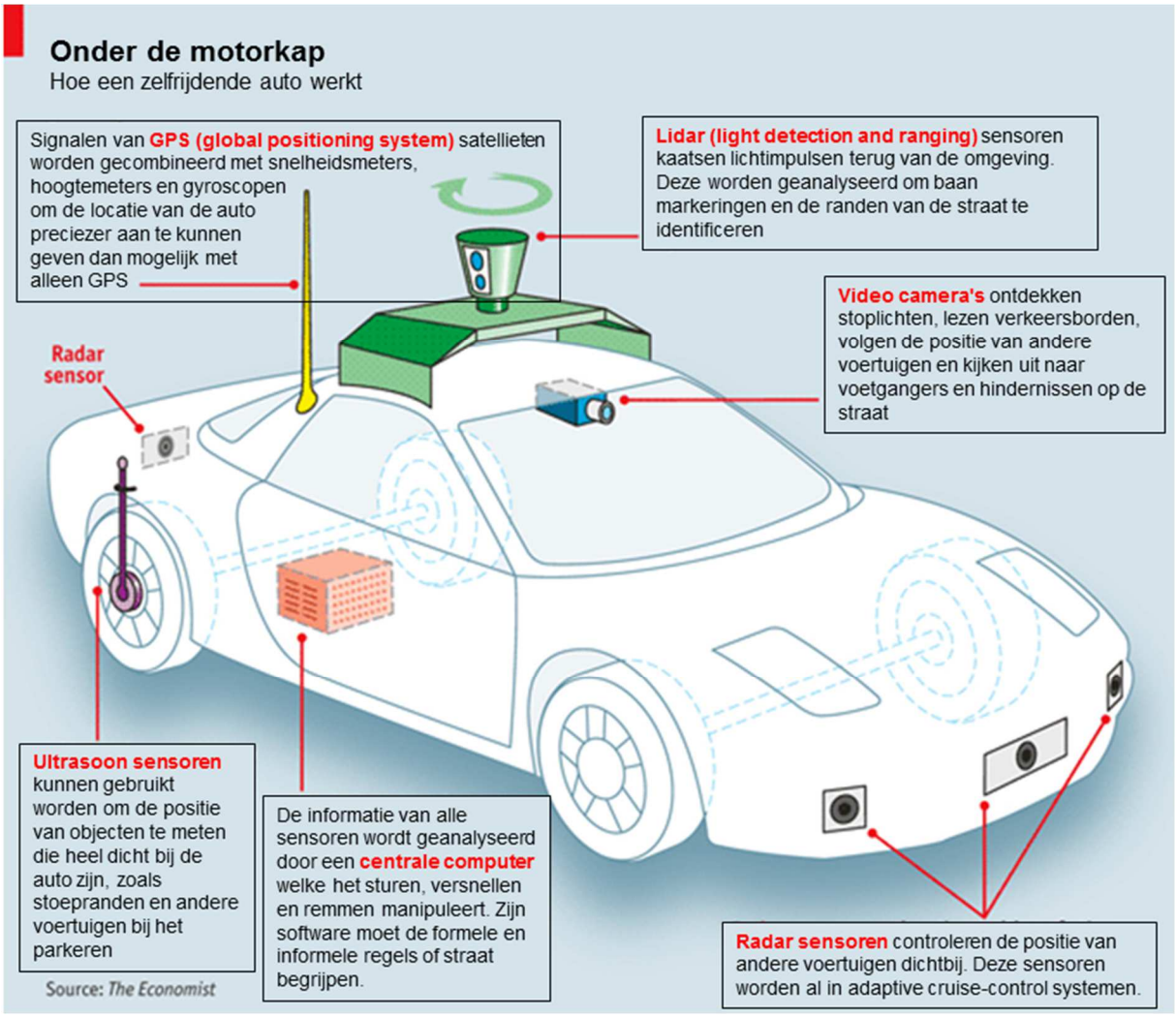
Level 3:

- De bestuurder kan de volledige controle van alle functies die belangrijk zijn voor het veilige rijden aan de auto overhandigen
- de auto kan laten zien, als hij de controle weer terug wil geven (bijvoorbeeld bij een bouwplaats op de snelweg of een andere situatie die hij niet kent)
- de bestuurder moet hierbij niet de hele tijd op straat kijken, maar het bestaat nog steeds de mogelijkheid om de controle weer over te nemen
- Voorbeeld: de auto's, die van Google in de VS getest worden

Level 4:

- de auto doet alles, wat anders de bestuurder zou moeten doen
- de mens die de auto start mag een plaats van bestemming aangeven, maar moet daarna niet meer in de auto aanwezig zijn

Appendix D: Sensors in Self-Driving Cars



Appendix E: Coding Schema

Codes	Topics
1. Technology Use	
1.1 Non-Standard	*Smart watch, NFC tags, E-Reader, Tablet*
1.2 Standard	*Smartphone, TV, Laptop/Computer*
2. Interest in New Technologies	
2.1 High	*Technische snufjes en gadgets gewoon leuk, leuk te weten wat nieuwe trends zijn*
2.2 Higher Than Middle	*Nieuwe gadgets wel leuk, maar hoeft niet nieuwste van nieuwste te zijn*
2.3 Middle	**-**
2.4 Lower Than Middle	*Wel leuk, maar moet totaal niet nieuwste dingen hebben, wacht altijd aantal jaren/sommige tijd*
2.5 Low	*Zo lang oude dingen gebruiken als zij werken, niet echt nodig, geen drang om die dingen te hebben, altijd de laatste persoon die nieuwe technologie heeft*
3. Frequency of Car Use	
3.1 Often	*4 of meer keer per week*
3.2 Sometimes	*2 tot 3 keer per week*
3.3 Rarely	*Minder dan 2 keer per week, bijjna nooit*
4. Person Driving Mostly	
4.1 Self	*Rijd liever zelf, vaak zelf*
4.2 50/50	*50/50*
4.3 Other	*Vaker bij iemand mee*
5. Automatization Experience	
5.1 Only Level 0 in most used car	*Geen level 1 of 2 in meest gebruikte auto*
5.2 Level 1	*(adaptive) cruise control, remondersteuning, andere level 1 automatisatie, niet voeten en handen loslaten*
5.3 Level 1 in most used car	*Cruise control (of ander level 1 automatisatie) in meest gebruikte auto*
5.4 Level 2	*Combinate van 2 keer level 1, voeten en handen loslaten*
5.5 Level 2 in most used car	**-**
6. Automatization Opinion	
6.1 Only Positive	*Superhandige functie, makkelijk, positief, mooi, leuk, ontspannend, handig*
6.2 Both Negative and Positive	*Makkelijk, handig als omgeving ervoor is*
6.3 Only Negative	*Gespannen als moet gebruiken*
7. Self-Driving Cars Opinion	
7.1 Mainly Positive	*Ideaal, cool, handig, leuk*
7.2 More Positive	*Interessant, leuk, maar nog testen nodig, veel voordelen, sommige risico's*

7.3 Both Negative and Positive	*Nuttig, maar moet wel werken*
7.4 More Negative	*Veiliger, maar meer vertrouwen in zelf, twijfel over ethische aspecten, wat als iets mis gaat?*
7.5 Mainly Negative	*Zou niet gebruiken, technologieën gaan mis*

8. Use Intentions

8.1 No Use Intentions	*Zou niet gebruiken*
8.2 When Proven	*Nu nog niet, als helemaal betrouwbaar is, als technologie helemaal ontwikkelt is, als bewezen*
8.3 Only Using, not Buying	*Niet kopen, maar wel car-sharing*
8.4 Buying	*Als betaalbaar is in de toekomst wel kopen*

9. Situations in which to use Self-Driving Cars in the Future

9.1 Always	*Altijd, in elke situatie*
9.2 Many Situations	*Alleen niet als voor het plezier wil rijden*
9.3 Some Situations	*Wel op rustige plekken, niet in een drukke stad*
9.4 Little Situations	*Alleen voor testen*
9.5 Never	*Nooit*

10. Imagined Feelings First Ride

10.1 Mainly Positive	*Verbazen dat auto zelf rijdt*
10.2 More Positive	*Angstig en spannend, niet druk om maken als bewezen*
10.3 Both Negative and Positive	*Eerst angstig, dan wennen, blij*
10.4 More Negative	*Zenuwachtig, machteloos*
10.5 Mainly Negative	*Heel bang, niet fijn, paniek*

11. Trust in Self-Driving Cars

11.1 Yes, in future when proven	*Ja, als verder ontwikkeld zijn*
11.2 Not yet, but maybe in future when proven	*Nog niet, maar als verder ontwikkelt is misschien*
11. 3 No, but might change	*Nee, maar misschien omdat nog niet bekend, mogelijk dat mening in toekomst nog veranderd*

12. Trust Contributors

12.1 Functionality	*Bewezen dat werken, statistieken over functionaliteit*
12.2 Knowledge	*Sensoren kennen, technische kennis over auto's hebben*
12.3 Predictability	*Als beter weet hoe die rijdt, weten wat in bepaalde situaties doet*
12.4 Control Possibility	*Nog kunnen overnemen als onbekende situatie aankomt*
12.5 Information Legal and Ethical Issues	*Meer informatie en wetten over wie verantwoordelijk is als iets misgaat*
12.6 Transitional Stage	*Eerst nog level 3 auto's, later niet meer nodig, zou remmen in willen hebben als in testfase zit, transitie periode nodig*

13. Important Sort of Evidence for Functionality

13.1 Tests by companies	*Testen, statistieken, laten zien dat ze werken*
13.2 Other people using cars	*Moet eerst van vele andere mensen gebruikt worden, dat het bij andere mensen werkt, recensies*
13.3 Using cars oneself	*Ervaring, zelf willen gebruiken*

14. Levels of Distrust in Self-Driving Cars

14.1 Technology is never perfect, might always fail	*Technologie kan altijd misgaan, geen 100% zekerheid*
14.2 Technology will work, but other problems might arise	*Technologie zou wel werken, maar hacking, of het geaccepteerd wordt, legale vragen en ethische vragen zijn nog een probleem*
14.3 When technology is developed and proven, no problems	*Als technologie helemaal ontwikkelt en getest is zou er niks meer misgaan*

Appendix F: Mapping of the Interview Subjects to the Behavioural Variables

Technology

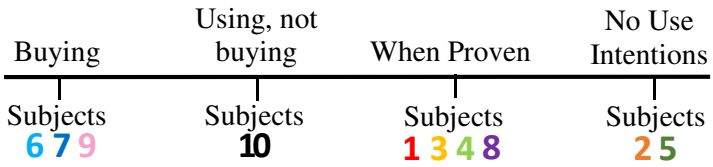
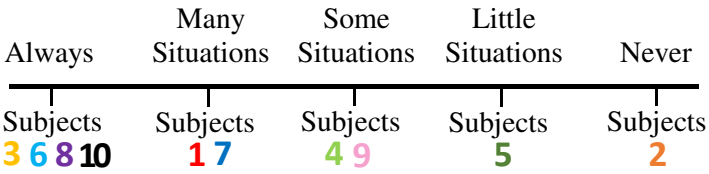
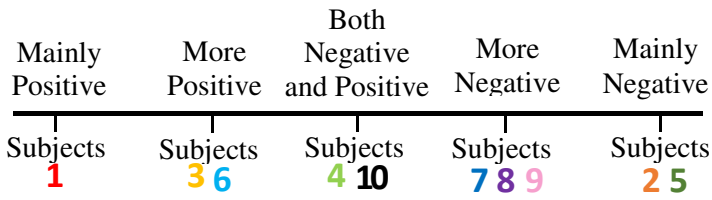
Variable	Mapping of the respondents
1. Technology Use	Non-Standard: Subjects 1 3 5 7 9 — Standard: Subjects 2 4 6 8 10
2. Interest in New Technologies	High: Subjects 7 9 — Higher than Middle: Subjects 1 — Middle: Subjects — Lower than Middle: Subjects 3 4 6 10 — Low: Subjects 2 5 8

Car Use, Experience and Opinion

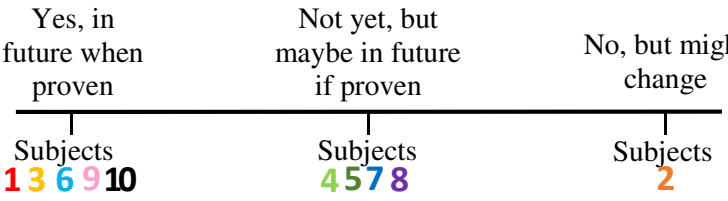
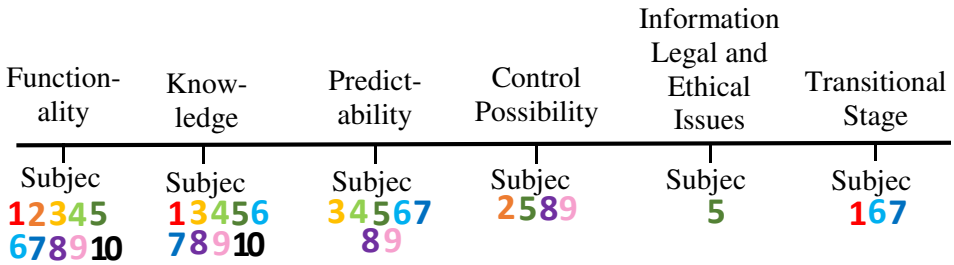
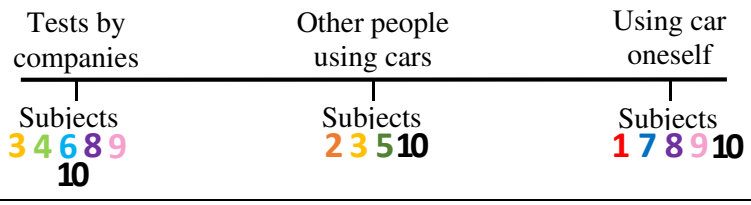
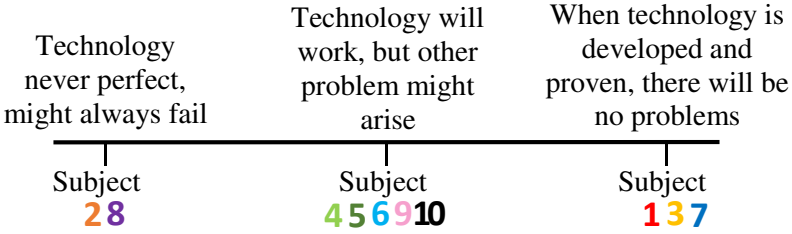
Variable	Mapping of the respondents
3. Frequency of Car Use	Often: Subjects 6 — Sometimes: Subjects 2 4 5 8 9 — Rarely: Subjects 1 3 7 10
4. Person Driving Mostly	Self: Subjects 4 6 9 10 — 50/50: Subjects 7 — Other: Subjects 1 2 3 5 8
5. Automatization Experience	Level 0 most used car: Subjects 1 2 3 8 — Level 1: Subjects 1 2 3 4 5 6 7 8 9 10 — Level 1 most used car: Subjects 4 5 6 7 10 — Level 2: Subjects 9 — Level 2 most used car: Subjects
6. Automatization Opinion	Only positive: Subjects 1 3 4 5 8 10 — Both negative and positive: Subjects 6 7 9 — Only negative: Subjects 2

Self-Driving Cars

Variable	Mapping of the respondents
7. Self-Driving Cars Opinion	Mainly Positive: Subjects 1 3 — More Positive: Subjects 7 10 — Both Negative and Positive: Subjects 8 9 — More Negative: Subjects 4 5 6 — Mainly Negative: Subjects 2

8. Use Intentions	
9. Situations in which to use Self-Driving Cars	
10. Imagined Feelings First Ride	

Trust in Self-Driving Cars

Variable	Mapping of the respondents
11. Trust in Self-Driving Cars	
12. Trust Contributors	
13. Important Sort of Evidence for Functionality	
14. Levels of Distrust in Self-Driving Cars	

Appendix G: Percentages of Respondents Sharing Variables

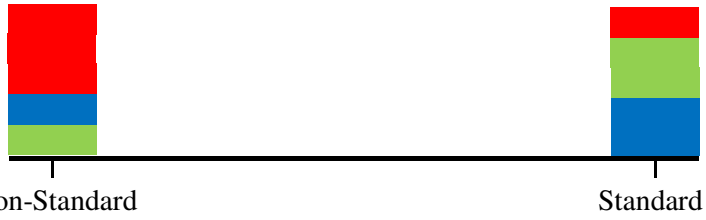
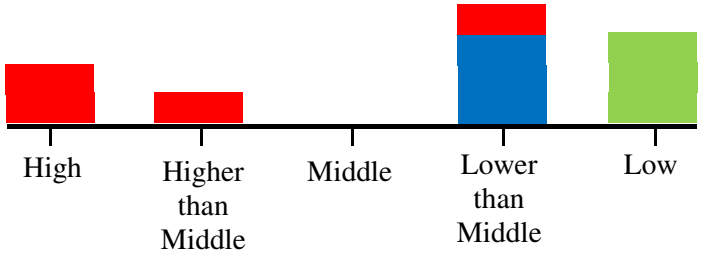
The percentages of the different behavioural variables sometimes add up to more than 100% when more than one answer was possible per respondent.

Category	Behavioural Variable	Range/Topics	%
Technology	1. Technology Use	Non-Standard	50
		Standard	50
	2. Interest in New Technologies	High	20
		Higher than Middle	10
		Middle	0
		Lower than Middle	40
		Low	30
Car Use, Experience and Opinion	3. Frequency of Car Use	Often	10
		Sometimes	50
		Rarely	40
	4. Person Driving Mostly	Self	40
		50/50	10
		Other	50
	5. Automatization Experience	Only Level 0 in most used car	40
		Level 1	100
		Level 1 in most used car	50
		Level 2	10
		Level 2 in most used car	0
	6. Automatization Opinion	Only Positive	60
		Both Negative and Positive	30
		Only Negative	10
Self-Driving Cars	7. Self-Driving Cars Opinion	Mainly Positive	20
		More Positive	20
		Both Negative and Positive	20
		More Negative	30
		Mainly Negative	10
	8. Use Intentions	No Use Intentions	20
		When Proven	40
		Only Using, not Buying	10
		Buying	30
	9. Situations in which to use Self-Driving Cars in the Future	Always	40
		Many Situations	20
		Some Situations	20
		Little Situations	10
		Never	10
	10. Imagined Feelings First Ride	Mainly Positive	10
		More Positive	20
		Both Negative and Positive	20
		More Negative	30
		Mainly Negative	20
Trust in Self-Driving Cars	11. Trust in Self-Driving Cars	Yes, in future when proven	50
		Not yet, but maybe in future when proven	40
		No, but might change	10

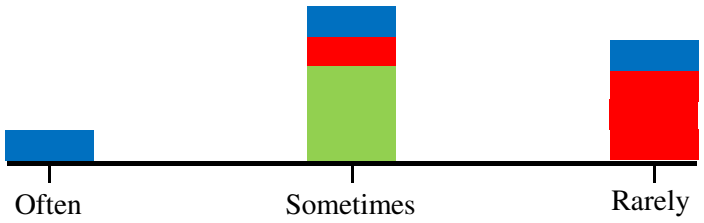
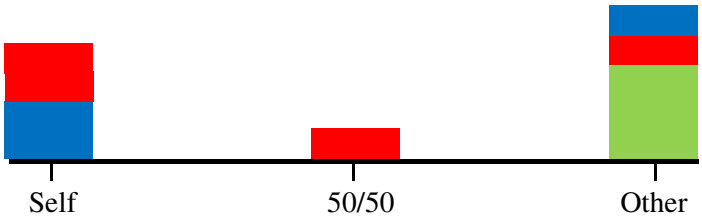
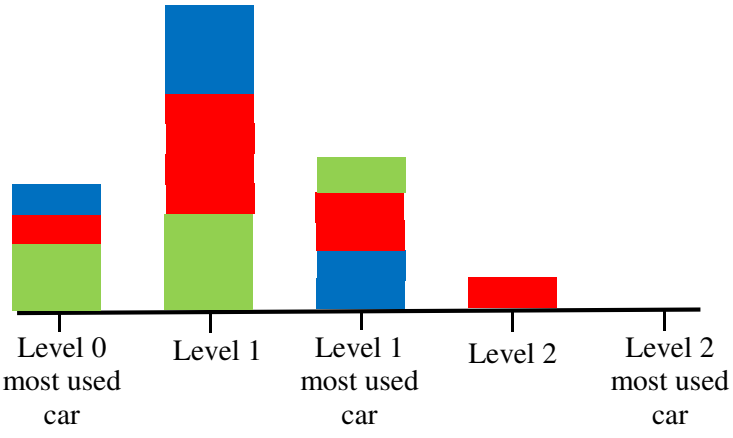
	12. Trust Contributors	Functionality	100
		Knowledge	90
		Predictability	70
		Control Possibility	40
		Information Legal and Ethical Issues	10
		Transitional Stage	30
	13. Important Sort of Evidence for Functionality	Tests by companies	60
		Other people using cars	40
		Using cars oneself	50
	14. Levels of Distrust in Self-Driving Cars	Technology is never perfect, might always fail	20
		Technology will work, but other problems might arise (hacking, legal, ethical, companies)	50
		When technology is developed and proven, no problems	30

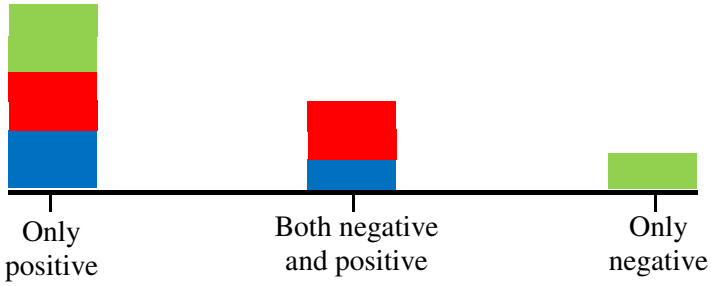
Appendix H: Differences Between and Within Personas (Graphic)

Technology

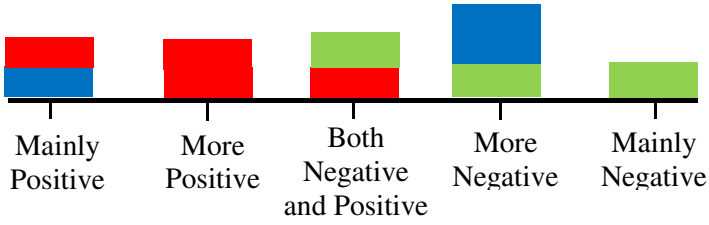
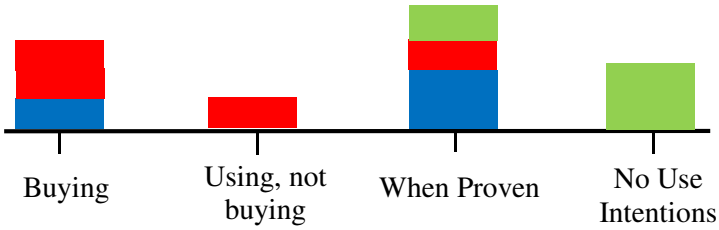
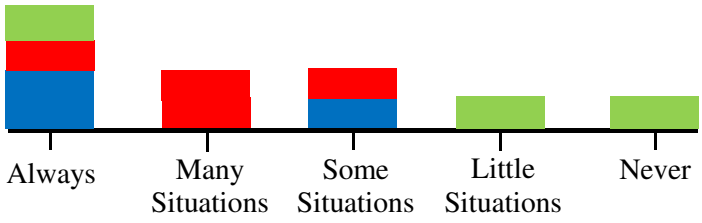
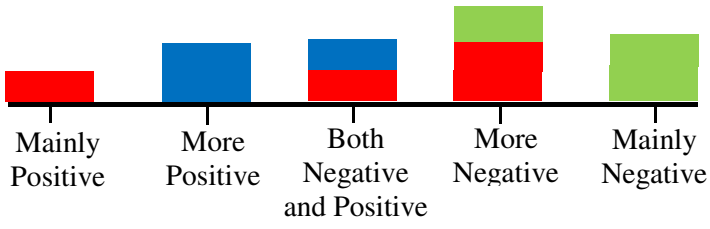
Variable	Mapping of the respondents
1. Technology Use	
2. Interest in New Technologies	

Car Use, Experience and Opinion

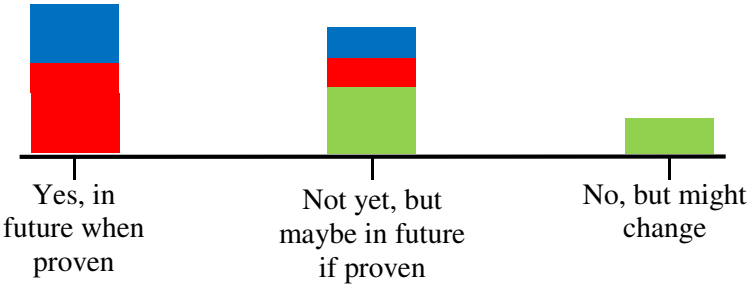
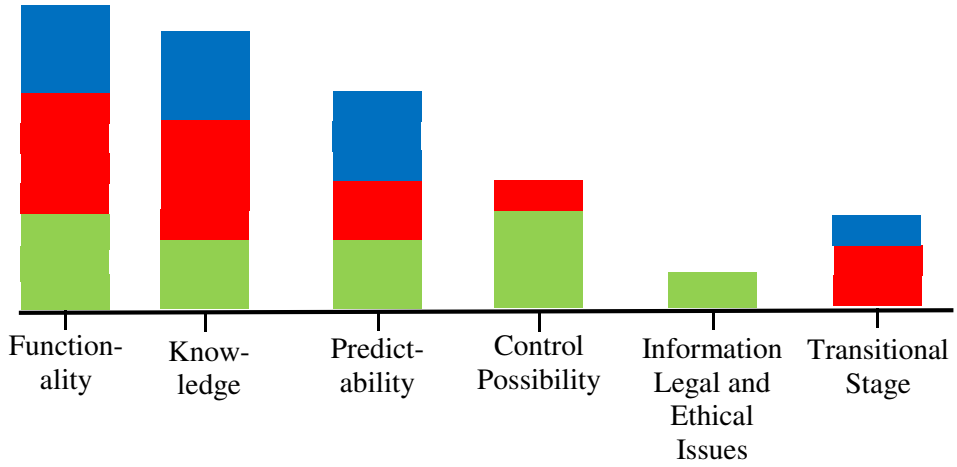
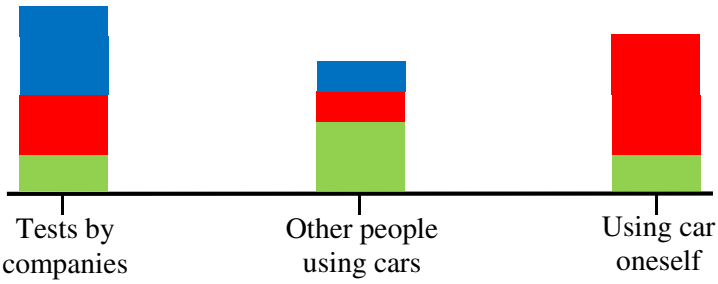
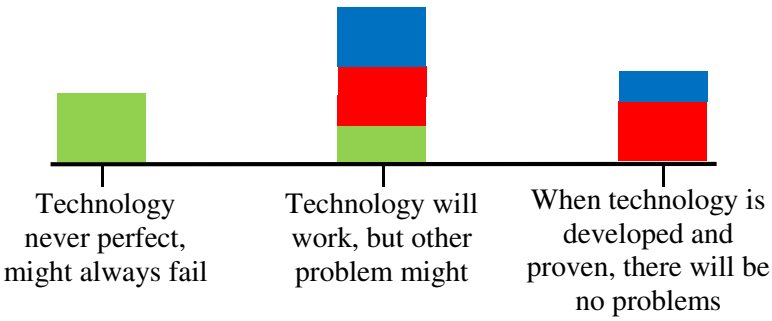
Variable	Mapping of the respondents
3. Frequency of Car Use	
4. Person Driving Mostly	
5. Automatization Experience	

6. Automatization Opinion	

Self-Driving Cars

Variable	Mapping of the respondents
7. Self-Driving Cars Opinion	
8. Use Intentions	
9. Situations in which to use Self-Driving Cars	
10. Imagined Feelings First Ride	

Trust in Self-Driving Cars

Variable	Mapping of the respondents
11. Trust in Self-Driving Cars	
12. Trust Contributors	
13. Important Sort of Evidence for Functionality	
14. Levels of Distrust in Self-Driving Cars	

Note. 'red' = persona Paul; 'blue' = persona Hans; 'green' = persona Hannah

Appendix I: Differences Between and Within Personas (Percentages)

The numbers sometimes add up to more than 1 when more than one answer was possible per respondent.

Category	Behavioural Variable	Range/Topics	Paul	Hans	Hannah
Technology	1. Technology Use	Non-Standard	.75	.33	.33
		Standard	.25	.67	.67
	2. Interest in New Technologies	High	.50	0	0
		Higher than Middle	.25	0	0
		Middle	0	0	0
		Lower than Middle	.25	1	0
		Low	0	0	1
Car Use, Experience and Opinion	3. Frequency of Car Use	Often	0	.33	0
		Sometimes	.25	.33	1
		Rarely	.75	.33	0
	4. Person Driving Mostly	Self	.5	.67	0
		50/50	.25	0	0
		Other	.25	.33	1
	5. Automatization Experience	Only Level 0 in most used car	.25	.33	.67
		Level 1	1	1	1
		Level 1 in most used car	.5	.67	.33
		Level 2	.25	0	0
		Level 2 in most used car	0	0	0
	6. Automatization Opinion	Only Positive	.5	.67	.67
		Both Negative and Positive	.5	.33	0
		Only Negative	0	0	.33
Self-Driving Cars	7. Self-Driving Cars Opinion	Mainly Positive	.25	.33	0
		More Positive	.5	0	0
		Both Negative and Positive	.25	0	.33
		More Negative	0	.67	.33
		Mainly Negative	0	0	.33
	8. Use Intentions	No Use Intentions	0	0	.67
		When Proven	.25	.67	.33
		Only Using, not Buying	.25	0	0
		Buying	.5	.33	0
	9. Situations in which to use Self-Driving Cars in the Future	Always	.25	.67	.33
		Many Situations	.5	0	0
		Some Situations	.25	.33	0
		Little Situations	0	0	.33
		Never	0	0	.33
	10. Imagined Feelings First Ride	Mainly Positive	.25	0	0
		More Positive	0	.67	0
		Both Negative and Positive	.25	.33	0
		More Negative	.5	0	.33

		Mainly Negative	0	0	.67
Trust in Self-Driving Cars	11. Trust in Self-Driving Cars	Yes, in future when proven	.75	.67	0
		Not yet, but maybe in future when proven	.25	.33	.67
		No, but might change	0	0	.33
	12. Trust Contributors	Functionality	1	1	1
		Knowledge	1	1	.67
		Predictability	.5	1	.67
		Control Possibility	.25	0	1
		Information Legal and Ethical Issues	0	0	.33
		Transitional Stage	.5	.33	0
	13. Important Sort of Evidence for Functionality	Tests by companies -> statistics	.5	1	.33
		Other people using cars -> reviews	.25	.33	.67
		Using cars oneself -> experience	1	0	.33
	14. Levels of Distrust in Self-Driving Cars	Technology is never perfect, might always fail	0	0	.67
		Technology will work, but other problems might arise (hacking, legal, ethical, companies)	.5	.67	.33
		When technology is developed and proven, no problems	.5	.33	0

Appendix J: Overview Respondents per Persona

Persona 1 – Paul

- Based on 4 respondents (number 1, 7, 9 and 10)
- Age ranges from 21 to 25 years (M = 22.75, SD = 1.48)
- 1 female, 3 male
- 3 Dutch, 1 German
- Studies are Psychology, Industrial Design (2x) and International Business Administration
- Uses more technologies than the standard ones
- High interest in new technologies
- Does not use a car very often
- Drives more often himself than being driven
- Has much experience with level 1 and 2 automatization in cars
- Has mixed feelings about level 1 and 2 automatization in cars
- Thinks positively about self-driving cars
- Has the intention to buy or use a self-driving car in the future
- Would use a self-driving car in most situations
- Imagines positive and negative feelings concerning the first ride in a self-driving car
- Expects to trust self-driving cars when they will be proven in the future
- Finds functionality and predictability of self-driving cars, knowledge about them and a transitional stage important contributors to his trust
- The evidence of the functionality of self-driving cars that he finds most important is experiencing one himself
- Believes that when the technology for self-driving cars is developed and tested it can be trusted completely

Persona 2 – Hans

- Based on 3 respondents (number 3, 4 and 6)
- Age ranges from 20 to 21 (M = 20.33, SD = 0.47)
- 1 female, 2 male
- All Dutch
- Studies are Psychology, International Business Administration and Mechanical Engineering
- Only uses the standard technologies
- Middle low interest in new technologies
- Uses a car sometimes
- Drives more often himself than being driven
- Has a good amount of experience with level 1 automatization in cars, mainly because the car he most often drives has level 1 automatization
- Thinks positively of level 1 automatization in cars
- Has mixed feelings when thinking about self-driving cars
- Intends to maybe buy or use self-driving cars when they are proven all the way
- Would use a self-driving car in some situations

- Has mixed imagined feelings of the first ride in a self-driving car
- Might trust cars in the future after they are proven all the way
- Finds functionality and predictability of self-driving cars and knowledge about them important as contributors to his trust in them
- Thinks that the most important sort of evidence for the functionality of self-driving cars are statistics coming from test made by the car companies
- Trusts in that technology in self-driving cars will work, but expects other problems to arise and cause distrust

Persona 3 – Hannah

- Based on 3 respondents (number 2, 5 and 8)
- Age ranges from 21 to 24 years (M = 22, SD = 1.41)
- All female
- 1 Dutch, 2 German
- Study is Psychology
- Only uses the standard technologies
- Low interest in new technologies
- Uses a car sometimes
- Is more often driven by others than driving herself
- Has some experience with level 1 automatization in cars
- Thinks quite negatively about level 1 automatization in cars
- Thinks quite negatively about self-driving cars in general
- Has no intention to use or buy self-driving cars in the future
- Would use a self-driving car in only few situations
- Has mainly negative imagined feelings concerning the first ride in a self-driving car
- Does not trust in self-driving cars, but does also not completely exclude this from changing under different circumstances in the future
- Finds functionality and predictability of self-driving cars, knowledge about them, a possibility to take back control and some information on legal and ethical issues (like who is responsible when something goes wrong) important as contributors to her trust
- Thinks that the most important sort of evidence for the functionality of self-driving cars are reviews from other people who already used the cars
- Has a high distrust in that technology could work without failing

Appendix K: Quote Translations

Vari-able	Original Dutch Quote	English Translation
7	Ik denk, dat het wel een idee is wat ideaal zou zijn, helemaal voor zakenmensen, die geen chauffeur hoeven.	I think that it really is an idea that would be ideal, especially for business people who do not need a driver.
	Alle sensoren, of, ja, technologieën die daar inzitten, moeten tegelijkertijd functioneren, en […] als bijvoorbeeld de video camera op eens uitvalt, dan kan dat een heel erg groot probleem zijn zo.	All sensors, or, yeah, technologies that are in there, have to work simultaneously, and […] if for example the video camera suddenly fails, then that can be a very big problem.
	Ik heb het volgens mij al laten merken, dat ik van het, in principe werkt het, het systeem is best wel waterdicht, maar ja, dus, het gaat om de keer dat het fout gaat, zeg maar.	I think I have already let on that I from it, basically it works the, the system is quite accurate, but yeah, so, it is about the time that it goes wrong, say.
8	Nee, zou ik me niet voor kunnen stellen, ik denk niet dat het helemaal weggaat. Ik heb er geen verstand van, maar ik denk dat het altijd wel blijft, dat jezelf nog wat moet doen.	No, I could not imagine that, I don't think that that completely goes away. I have no knowledge of it, but I think that it always remains that oneself still has to do something.
	Ja als het daar eenmaal wat wijder verspreid is, dan lijkt het me wel interessant inderdaad om een zelfrijdende auto te gebruiken.	Yes, once it is more widespread, then does seem interesting indeed to use a self-driving car.
	Ja, eigenlijk wel, als de technologie helemaal ontwikkelt is wel, en het bewezen is, […] dat het gewoon steeds nog veiliger wordt, dat steeds meer functies, en dat het steeds beter wordt, en als het dan aan het eind bewezen is, ja, dan zou ik wel over gaan.	Yes, actually, if the technology is entirely developed really, and it is proven, […] that it just becomes increasingly more safe, that increasingly more functions, and that it gets increasingly better, and if it is proven at the end, yes, then I will go over.
9	Misschien een testritje ergens, ofzo. Op een oefenbaan. Maar nee, ik zie het echt niet voor me om dat helemaal gewoon in een drukke stad te doen.	Perhaps a test ride somewhere, or something. On a practice track. But no, I really can't imagine to just do that in a busy city.
	Als de technologie dan heel prior is […] dan zou ik het misschien voor een […] paar keer wel proberen, […] maar ik zou niet durven om […] dan helemaal in een drukke stad.	When the technology is very prior […], then I would probably try it […] some times, […] but I would not dare to […] then completely drive in a busy city.
	Ja, naja, naar werk is handig, voor de rest is het ook handig als je gedronken hebt, dat je bijvoorbeeld niet zelf hoeft, […] Als je een stukje gaat rijden voor je plezier, zeg maar, dan lijkt het me leuk om zelf te kunnen rijden in plaats van dat de auto het zelf doet.	Yes, well, to work is useful, for the rest it is also useful if you've been drinking that you for example don't have to yourself, […]. When you drive a bit for fun, let's say, then it seems nice for me to drive myself instead of that the car does it itself.
10	Heel fijn, heel relaxed. […] Ik denk niet, dat ik me zo druk om zou maken, ik denk, dat ik het vertrouw.	Very nice, very relaxed. […] I think that I will stay calm, I think that I trust it.
	Naja, eerst is die verbazing aangezien dat ik waarschijnlijk de eerste keer zit in zo'n auto, maar ik denk dat heel snel went en dat het dan gewoon, bijna gewoon normaal voor je is en dat je het dan ook gewoon makkelijk vind.	Well, first there is surprise because I probably sit in such a car for the first time, but I think that you get used to it very quickly and that it is then just, nearly just normal for you and that you then just find it easy.
	Dus die eerste paar keer denk ik als ik naar mezelf kijk zou ik het wel heel eng vinden,	So, the first few times I think when I look at myself, I would find it very strange, just,

	gewoon, ja, in paniek zo om me heen kijken of alles wel goed gaat.	yeah, looking around in panic if everything works well.
11	[Denk je dat je vertrouwen in de zelfrijdende auto zou hebben?]	Do you think that you would trust the self-driving car?
	Nee.	No.
	Ik denk als het zich bewijst, dan ja, dan wel.	I think if it proves itself, then yes, I would.
	Op dit moment niet. Op dit moment zou ik echt angstig zijn om te rijden, zou ik de controle niet durven weg te geven, als het echt technologie meer ontwikkelt is, dan wel, maar, nee, nu nog niet.	Not at this moment. At this moment I would be really scared to drive, would I not dare to give away control, if the technology is really further developed, then I would, but, no, not yet.
12	Ik denk ik zou meer vertrouwen in die auto hebben als daar gewoon iets, een pedaal ofzo nog inzit, omdat ik dan weet dat ik, als ik het zelf wil, die controle kan overnemen. Dus, dan voel je niet zo machteloos zo alsof je niet, helemaal niets kan doen.	I think I would have more trust in the car when there is just something, a pedal or something is still in there, because then I know that I, if I want to myself, can take back control. So, then you don't feel as powerless as if you can't, can't do anything.
	Als ze eenmaal echt kunnen aantonen dat iets werkt en voor een wat langere tijd dan zal het ook wel werken.	Once they can really prove that something works and for a longer time then it will probably work.
	Ik denk, dat ik daar wel een transitie periode voor nodig heb, dat ik het eerst nog in moet kunnen grijpen, voordat ik de controle helemaal uit handen geef.	I think that I need a transition period for that, that I first have to be able to still intervene, before I give away control completely.
13	Ik denk een stukje ervaring. Ik denk dat vooral. Je kent het nu eigenlijk ook niet.	I think some experience. I think that especially. You also really don't know it now.
	Misschien […] moet het eerst […] van vele mensen gebruikt worden en […] dat ik meer zeker ben dat er niets gaat gebeuren en dat deze technologie echt zonder fouten functioneert.	Maybe it […] first has to be used […] by many people and […] that I am more sure that nothing is going to happen and that this technology really works without mistakes.
	Mijn vertrouwen, ja, dat wordt eigenlijk daardoor bepaald, of dat door tests kan uitwijzen dat het ver is.	My trust, yeah, that is actually determined by if it can show through tests that it is far.
14	[Hoezo zou je geen zelfrijdende auto willen kopen?] Omdat er heel […] veel technologie wordt gebruikt en ik ken dit van mijn smartphone of van mijn technologieën dat er vaak ook een fout gebeurd.	[Why wouldn't you buy a self-driving car?] Because very […] much technology is used and I know this from my smartphone or from my other technologies that also often a mistake happens.
	Naja, inderdaad, de veiligheid kan zoiets gehackt worden, kan mijn route getraceerd worden. […] Want op zich de technologie zelf zou wel gewoon goed werken, in mijn optiek, maar, inderdaad, als er nou wel een keertje iets voorvalt.	Well, indeed, the safety, can something like that be hacked, can my route be traced. […] Because in itself the technology itself would just work well, in my opinion, but, indeed, when now again sometime something happens.
	Nou, zij moeten zichzelf eerst bewijzen dat zij ook daadwerkelijk niet aanrijden of weet ik veel wat allemaal en ik denk dat dat vooral het belangrijkste is.	Well, they first have to prove themselves that they actually don't ride up or something else and I think that that is especially important.