UNIVERSITY OF TWENTE.

Bachelor Thesis:

Analysing Driving Instructor's Gestures to give Recommendations for an Interactive Tutoring/Feedback System for Partially-automated Cars

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Abstract

The goal of the present study was to give recommendations for an interactive, in-car tutoring/feedback system. That system has the purpose of supporting first-time users of partially-automated cars to use its assistive systems correctly. To determine what type of instructions/feedback the envisioned system is supposed to provide throughout different driving areas, the present study examined gestures of driving instructors. The aim was to determine what type of feedback is used most by driving instructors in three different driving areas. We expected the results to show more corrective feedback being used by instructors while driving through city areas and more reflective feedback being used during rural areas or highways. To collect data cameras were mounted in a driving instructor's car recording both the inside and outside of the car. Next, observed gestures of the instructors were coded and classified as different types of corrective or reflective feedback. Additionally, the driving area was noted in which the gestures occurred. Results show more corrective feedback being used in city- and rural areas and more reflective feedback used on highways. Thus, in city areas we recommend the envisioned tutoring/feedback system to give short and precise instructions of how to handle a situation using the assistive devices of the car. In rural areas the tutoring/feedback system should direct attention to road-characteristics and how the driver should handle them. While driving on highways, the system could help the driver to improve his/her understanding of assistive systems by reflecting on given situations.

1. Introduction

1.1 Introduction to Automation & Motivation for Tutoring/Feedback System

In recent years the process of driving a car changed step by step in terms of cars becoming more autonomous. That change was accomplished with the help of assistive technological devices which intervene in the task of driving (Naujoks, Purucker, & Neukum, 2016). Assistive systems take over certain tasks, like steering or controlling the speed, while leaving the driver with other tasks like monitoring the environment (Eichelberger & McCartt, 2016; Tettamanti, Varga, & Szalay, 2016). Cars equipped with these automated systems are categorized into a five-level framework in which automated cars are ranked by the number of driving tasks the systems take over (Tettamanti et al., 2016). More information about this framework and the respective levels of automation can be found in the background chapter of this paper (see Appendix A).

The functionalities of these automated systems can be difficult to understand and used correctly, especially for first-time users. Previous research suggests that, for the driver to know when to safely use new automated systems, receiving information about the system's handling before the driving process is not sufficient enough (Boelhouwer, van den Beukel, van der Voort, & Martens, 2018). Additionally, it was found that drivers do not fully understand the functions of these systems resulting in misunderstandings of who is responsible for the driving-related tasks (Casner, Hutchins, & Norman, 2016). Therefore, drivers, especially first-time users of automated cars, need training and support in using these automated systems.

The present study aims at providing recommendations for guidelines of an in-car, interactive tutoring/feedback system for partially-automated cars. The purpose of this envisioned system is to assist first-time users to use the assistive systems correctly. Partially-automated cars, classified as second-level of automation, are defined by *one or more* assistive devices taking over the tasks of steering, acceleration, and deceleration (Tettamanti et al., 2016). Drivers perform the remaining driving related tasks or monitor the area. The reason for targeting partially-automated cars is that their driving-task allocation is not one-sided (Martens & van den Beukel, 2013). That is, these cars can be more confusing regarding the task allocation compared to cars in complete automation control or complete manual control on behave of the driver (Martens & van den Beukel, 2013). Thus, it is especially important for partially-automated cars that the driver understands the functionalities of the assistive systems.

1.2 General Ways of giving Feedback/Teaching

To establish what kind of instructions the tutoring/feedback system is supposed to provide the present study takes a closer look into general ways of how individuals are taught procedural skills, that is skills needed to sufficiently handle devices such as assistive systems of cars (Beanland, Goode, Salmon, & Lenne, 2013). The approach used by the present study is teaching by giving feedback. One main approach is giving corrective feedback to support the learning process of individuals (Hewson & Little, 1998). Corrective feedback is defined by visual, auditory, or tactile indications that the student showed an incorrect action and, additionally, displaying the correct action (Rogers, Berg, Boettcher, Howard, Justice, & Schenk, 2009). Another feedback approach used by the present study is giving reflective feedback (Cantillon & Sargeant, 2008). Reflective feedback encourages individuals to reflect on past actions and events to recognise performance gaps and indicate possible improvements (Cantillon & Sargeant, 2008). More general information about feedback methods can found in Appendix A. In the present study we distinguished between direct indications of incorrect behaviour by displaying the correct action as corrective feedback and reflections on actions and events with following indications for improvements as reflective feedback.

As a next step, the present study looks at how instructions and feedback should be conveyed. In the research of Roth (2001) it was shown that verbal as well as gestural instructions and feedback support the learning process with gestures highlighting important aspects of spoken instructions. For example, gestures can be used to draw attention to salient features or to refocus attention using a pointing movement (Kastens, Agrawal, & Liben, 2008). Moreover, gestures can be used by instructors to recreate a situation by using these gestures to create three dimensional shapes, positions of objects, or orientation (Kastens et al., 2008). The same gestural technique can be used to enact desired actions (Kastens et al., 2008).

The present study analysed the gestural instructions and feedback of driving instructors teaching students how to drive during practical lessons. It was decided to use instructors due to their similar dynamic as teacher and student compared to the envisioned dynamic of the tutoring/feedback system and first-time users of partially-automated cars. Also it was decided to analyse just the gestures since they were found to highlight the most important aspects. Corrective feedback gestures, for example pointing somewhere to direct attention, could be converted into an advice of the envisioned system directing the attention to aspects in the environment in which the task allocation between driver and system about to change. Reflective feedback gestures, such as recreating situations, could be converted to the system providing options between which the driver can choose while the car is driving. For example, the system could offer the choice to take over certain task or letting the driver be in full control.

1.3 Adjustment of Tutoring/Feedback System to different Driving Areas

The envisioned tutoring/feedback system has to adapt the type of instructions and feedback it presents to the driver to different driving situations. The reason why the system has to adapt the type of instructions/feedback it presents to the driving area is because these areas differ in terms of driving related demands (Gold, Körber, Lechner, & Bengler, 2016). In general, there are three driving areas, urban, rural, and highway, which differ in terms of their respective characteristics (Fastenemeier, 1995). Urban areas, for example, often involve a higher traffic density as well as a higher street network connectivity (Marshall & Garrick, 2011). These imply more traffic, a larger number of intersections, and increased occurrence of traffic regulators such as traffic lights (Fastenemeier, 1995). In turn these characteristics increase the number of tasks the driver has to perform, like forced speed adjustments, compared to rural roads or highways increasing the drivers demand (Marshall & Garrick, 2011). On the other hand, rural roads are often characterized by monotonous and straight road courses triggering boredom of the driver and leading to fatigue (Wang, Quddus, & Ison, 2013). Lastly, highways are characterized by multiple lanes in each direction leaving the driver with several options, for example, staying in the same lane or changing lanes (Fastenmeier, 1995). When analysing the gestural instructions and feedback of the driving instructor, the driving area in which they occurred was noted to investigate whether the type of instructions/feedback changes according to the driving area.

1.4 The Present Study

During this quantitative exploratory study, video material of driving instructors together with their student during driving lessons and the driving area were recorded. One camera recorded the driving instructor and another camera recorded the outer environment of the driving car. These videos were used to code the behavioural instructions and feedback the instructor gave and to note in what driving area they occurred resulting in the two categorical variables of the present study (i.e. Behaviour & Driving Area).

To code the behaviour of the instructors, a coding scheme for gestural instructions and feedback (i.e. hand- & head gestures and other non-verbal feedback) was established. The complete coding scheme can be found in the variable part of the method section. That coding scheme then was used to classify observed gestures into the respective types of either corrective- or reflective feedback. The meaning of the gestures were determined through the instructor's verbal remarks, the reaction of the student, and the gesture itself. Gestures encompassing corrective feedback were recognisable by shorter and more concrete body movements like pointing in a direction. Reflective feedback was recognisable through prolonged hand movements or the use of notepads to illustrate and explain a certain situation. The driving area was coded by determining the different infrastructures of three road types of city, rural, and highway. The coding scheme was based on Fastenmeier's table of road types and their variations (Fastenmeier, 1995). A more detailed description of the coding scheme for driving areas can be found in the method section.

As a next step the occurrences of the gestural feedback types in each driving area were counted to examine what types of corrective or reflective feedback was used most in each driving area. It was assumed that, due to the higher number of road characteristics in city areas, more corrective feedback gestures were used by the driving instructors. During rural- and highway areas we expected to find more prolonged gestures, classified as reflective feedback. Due to the low number of road characteristics in these areas we expected to find more reflective and explaining feedback gestures. These results can be used as recommendations for an interactive tutoring/feedback system by adopting the meaning of the gestures to instructions provided by the system. For example, the corrective feedback gesture used to indicate a certain behaviour which the student should perform could be adopted as instructions of the tutor/feedback system by providing information about driving tasks the first-time user is supposed to take over.

The research question of this study was what type of behavioural feedback (i.e. corrective or reflective) was *used most* by the driving instructors in each driving area (i.e. city, rural, highway). To confirm the relationship between type of feedback used by the instructors and driving area, we expected to find an association between the behaviour and the driving areas. Additionally, we expected the results to show that more corrective feedback is presented while driving through city areas and more reflective feedback while driving through rural and highway areas.

2. Methods

2.1 Participants

During the recording of the driving lessons, 8 different driving instructors (7 men, 1 women, M_{age} = 51.6 years, SD_{age} = 10.8, age range: 33-61 years) were recorded. Only driving instructors with at least 1 year of teaching experience and sufficient knowledge of driving and teaching in the city and rural areas of the region of Enschede were chosen ($M_{experience}$ = 18.9, $SD_{experience}$ = 14.4, experience range: 1-40 years). Every instructor had the Dutch nationality. The recorded driving lessons included 16 driving students (11 men, 5 women). The students all had to have had 5 driving lessons or more so that they already learned the basic controls of how to drive a car. Instructors and students were aware of being recorded and gave their approval beforehand by signing an informed consent. Furthermore, the recordings were approved by the Ethics Committee for Behavioural and Management Science at the University of Twente. Additionally, two raters were used to determine inter-rater reliability.

2.2 Materials

Two 'GoPro Hero 4' cameras were mounted in the car of the driving instructor. One camera was directed towards the instructor and student while the other camera was directed towards the driving area. Both cameras recorded with a 1920x1080 resolution. Additionally, auditory recordings of the inside of the car were made using the same camera. The resulting video material was analysed and coded using the program “BORIS” which is a open-source event-logging software used to code audio as well as video observations (Friard & Gamba, 2016). In order to classify the gestures of the driving instructors into corrective or reflective feedback, a coding scheme was established. It includes all the gestures performed by the driving instructor and their respective meanings. An example is approving feedback indicated by a head nod. Furthermore, another coding scheme, compiled by orienting on the work of Fastenmeier (1995), was used to classify the driving areas (i.e. city, rural, highway). This coding scheme lists the most common characteristics of each road type, which are assigned to a specific code as well (see Variable section).

2.3. Design

The observed gestures of the driving instructors as well as the infrastructure of the different driving environments were analysed by using the coding method. Therefore, observed gestures were either classified as corrective- or reflective feedback. Additionally the driving area in which the respective gestures occurred were coded into either city, rural, or highway area. The aim was to find out what type of feedback was used most in each respective area. The association between behaviour and driving area was calculated to see whether there is a significant difference in gesturing frequencies throughout the driving areas. We used inter-rater reliability to verify the classification we observed.

2.4 Procedure

For this study, the participants (i.e. driving instructors & driving students) were video recorded during the practical driving lessons. Before that, both parties were informed of being recorded and had to agree to that by the means of an informed consent which they had to sign. While driving, the researcher aimed not to interfere in the interactions between instructor and student. Both parties were told to try to avoid non-driving related topics. Additionally, the driving instructor was asked to cover all three road-types during their driving lessons. The participants were only told that we were generally interested in the interaction between instructor and student.

2.5 Variables

This study included two categorical variables. The behaviour variable included the codes of the gestural instructions and feedback of the driving instructors. To code the behaviour, a coding scheme for gestural instructions and feedback of driving instructors (i.e. hand- & head gestures and other non-verbal feedback) was established. The coding scheme was inspired by the research of Kline (2017) with some categories like 'Direct Attention' and 'Feedback' derived directly from Kline's work and used as feedback types in the present study. Some categories from the research of Kline (2017) were changed for the present study's goal or added after reviewing the video material, for example, reflecting on current or previous situations. Also the categories 'Abstract communication' and 'Demonstration' were used but in different forms. Abstract communication was changed into 'Explain Rules', 'Explain Equipment' and 'Test Theory/Knowledge'. The category 'Demonstration' which derived from the research of Kline (2017) was used in the present study when the instructor performed an action himself. Furthermore, the aforementioned feedback types used by the present study were classified either as corrective feedback or reflecting feedback (see Tables 1 & 2). The observed gestures which the instructors used to communicate the respective corrective feedback types can be seen in the second column of Table 1.

Table 1.

First Category of Dependent Variable 'Behaviour': Feedback Types classified as 'Corrective Feedback' and their respective Gestural Execution performed by the Instructors

Corrective Feedback	***Observed Gestures***
Feedback	• Thumbs up • Thumbs down • Head nod • Head shake
Direct Attention	• Point outside • Point inside • Hand up/Warning
Indicate Desired Behaviour	• Wave movement forward (faster) • Up down movement (slower) • Hand gesture (come) • Hand points towards desired direction • Draw situation (gesture and/or pencil/tablet • Act out • Perform action himself/herself

The second table displays the second category 'Reflective Feedback' of the first categorical variable. This category included five types of reflective feedback (see Table 2). Again, the respective executions of these five types can be found in the second column of Table 2.

Table 2.

Second Category of Dependent Variable 'Behaviour': Feedback types classified as 'Reflective Feedback' and their respective gestural execution performed by the instructors

Reflective Feedback	***Observed Gestures***
Reflect on previous situation	• Draw situation • Act out
Reflect on current situation	• Draw situation • Act out
Explain traffic rules	• Draw situation • Act out
Explain car equipment	• Draw situation • Act out • Adjust equipment
Test Theory/Knowledge	• Act out

However, during the coding process of the behaviour some non-verbal instructions and/or feedback were left out. This was the case, for instance, if the driving instructor used a gesture as command of which direction the student is supposed to drive. These kinds of gestures were left out because this study aims at giving recommendations for an interactive tutor/feedback system instead of a navigation device. Furthermore, non-verbal instructions and/or feedback were left out if the instructor did not address the driver but the researcher or if the topic of their conversation was not related to driving at all. Secondly, the driving area was determined by the road types and their respective characteristics (see Table 3).

Table 3.

Driving Area and their respective road characteristics

Road Type	***Description of Road Type***
City roads	• 2 or more roadways; roads divided by green middle line; city ring road • one roadway; wide; at least 2 lanes in each direction • one roadway; wide; at least 2 lanes in one each direction; severe rutting • one roadway; 2 or 3 lanes • one roadway; 2 or 3 lanes with severe rutting • tight roadway • one way street
Rural roads	• at least 2 lanes; clear road lines; smooth curves • old style; unclear or missing road lines; sharp curves
Highway	• each direction consists of 3 or more lanes; wide side road lines; emergency lane • each direction consists of 2 lanes; wide side road lines; emergency lane • each direction consists of 3 or more lanes; thin or no side road lines; no emergency lane • each direction consists of 2 lanes; thin or no side road lines; no emergency lane • with parking or service area on the lane

2.6 Analysis

To analyse the results, a cross-table was established showing the frequencies of the categories of the first categorical variable 'Behaviour' in the categories of the second categorical variable 'Driving Area'. As a next step the percentages in each cell of the cross-table were calculated to illustrate the distribution more clearly. The Chi-square test of Independence was used to determine whether there is a significant difference in gesturing frequencies throughout the driving areas. A post hoc test was conducted using the residual analysis method to determine which specific categories contributed to the overall significance (Beasley & Schumacker, 1995; Garcia-Perez & Nunez-Anton, 2003). Also the inter-rater reliability was used to calculate the accuracy of the codes of both variables. For the inter-rater reliability, a second rater coded randomly assigned parts of each video. The codes of the second rater were compared to the codes of the first rater and their reliability was calculated by using Cohen's kappa.

3. Results

Starting with the variable of behaviour a total of 1468 gestures were observed ($M_{per\ instructor}$ = 183.5, SD = 87.4, range of observed gestures per instructor: 53-342). Regarding the data of the independent variable 'Driving Area', every 5 seconds of a video was given a road-type code. However, some area codes had to be ignored if, for example, the car was parking or no gestures were observed at that time. Therefore, just 82% (N = 1198) of valid area codes were used during the statistical analysis. The inter-rater reliability was carried out by two raters in total. Next, Cohen's kappa was calculated for both variables and interpreted by orienting on the work of Mchugh (2012) and his table of interpreting Cohen's kappa. As it turned out the variable 'Behaviour' has a weak level of agreement (κ = 0.47, SE = 0.05). The variable 'Driving Area' has a weak level of agreement, too (κ = 0.58, SE = 0.01). Thus, 15% to 35% of the data is reliable (Mchugh, 2012).

The final data set was used to set the dependent variable 'Behaviour' in relation to the independent variable 'Driving Area'. This was done in order to answer the research question what category of feedback was used most by the driving instructors in each driving area. In Figure 1 the frequencies of corrective- and reflective feedback used in the respective driving areas are shown to illustrate what type of instructions/feedback was used most in which driving area.

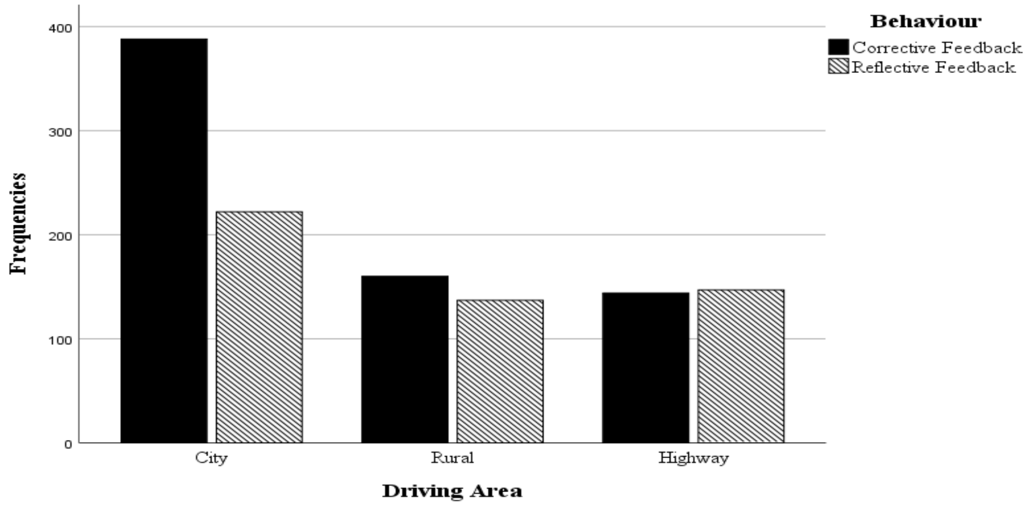

Figure 1. Bar Chart illustrating the Frequencies of Corrective- and Reflective Feedback Gestures used by the Driving Instructors in each Driving Area

The Chi-square test of Independence was used to examine the actual association between the two categorical variables. Looking at the results of this statistical test the association between the category 'Behaviour' and the category 'Driving Area' was significant, χ^2 (2, N = 1198) = 18.6, p < .001, confirming the association between the categories. However, after performing a post-hoc residual analysis (with an adjusted α-level of .008) it became evident that only the frequencies of corrective and reflective feedback in the city and highway area (respective p-values < .008) significantly contributed to this significance of differences between the levels.

As a next step, the frequencies of the respective types of the dependent variable 'Behaviour' used throughout the driving areas were analysed. This was done to gain a deeper understanding of which types of corrective feedback as well as reflective feedback had been used most by the instructors throughout the different driving areas. Therefore, Figure 2 illustrates the results of the types of corrective feedback used by driving instructors throughout the driving areas.

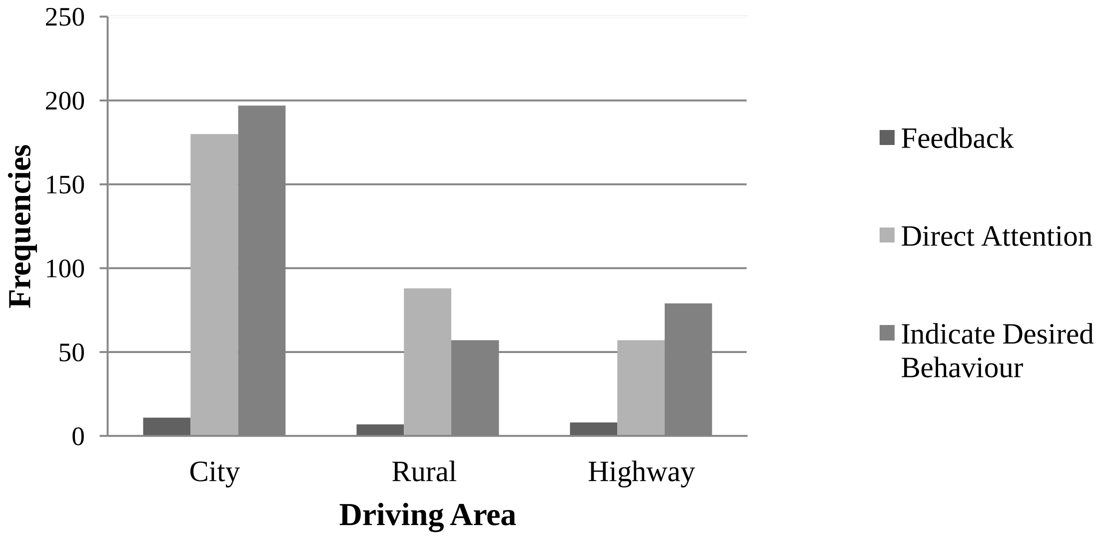

Figure 2. Bar Chart illustrating the Frequencies of Corrective Feedback Types used throughout the three Driving Areas

Results show a significant association between the respective types of corrective feedback and the different driving areas. χ^2 (4, N = 692) = 9.69, p < .05. Post hoc analysis, however, revealed no specific frequency of corrective feedback types significant enough (each p-value > adjusted α-level of .005) to contribute to the significance of differences between the levels. Next, the frequencies of reflective feedback types used throughout the different driving areas is shown in a bar chart (see Figure 3).

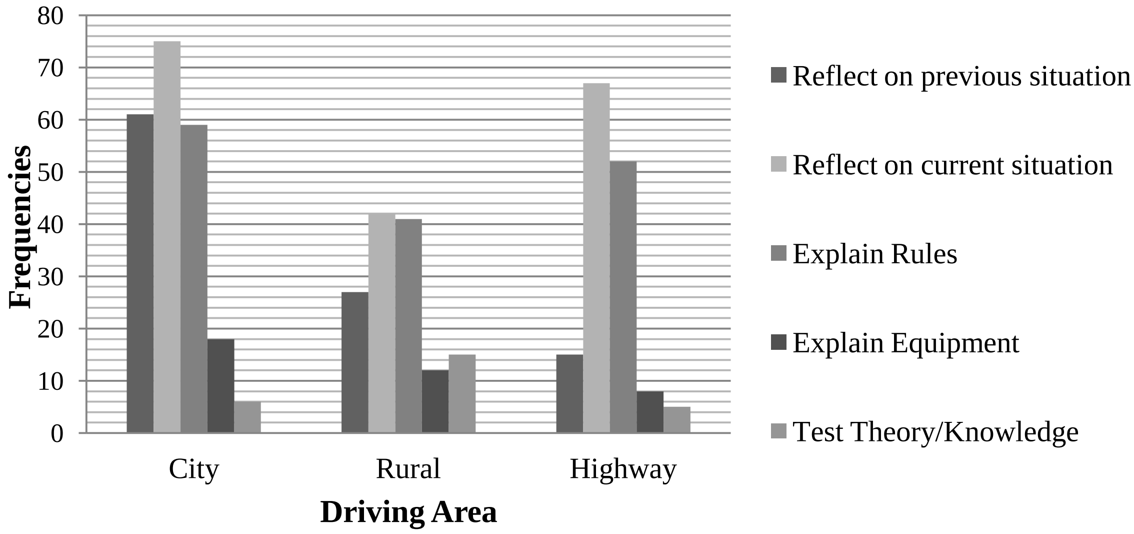

Figure 3. Bar Chart illustrating the Frequencies of Reflective Feedback Types used throughout the three Driving Areas

Again the association between the respective types of reflective feedback of the dependent variable "Behaviour" and the independent variable "Driving Areas" was found to be significant, χ^2 (8, N = 503) = 33.93, $p < .001$. The frequencies of "Reflect on previous situation" in city and highway areas and "Test Theory/Knowledge" in rural areas (respective p-values < adjusted α-level of .003) were found to significantly contribute to the significance of difference between the levels .

4. Discussion

4.1 Theoretical Reflection & Implications

The research question of the present study was what type of behavioural feedback (i.e. corrective or reflective) was *used most* by the driving instructors in each driving area (i.e. city, rural, highway). Looking at Figure 1, a large number of gestures, classified as corrective feedback, were observed in city and rural areas and slightly more reflective feedback gestures in highway areas. In line with our expectations, more corrective feedback gestures were observed in city areas and more reflective feedback gestures were observed in highway areas. We expected to find more reflective feedback gestures while being situated in rural areas, however, results show that more corrective feedback was presented. Overall, a strong association was found between the observed behaviour and the driving area, however, only the frequencies of behaviour in city and highway areas were found to significantly contribute to this association. Additionally, overall significant associations were found between the respective types of both corrective and reflective feedback and the driving areas.

Aforementioned literature stated that in city areas an increase of the number of driving-related tasks occurs caused by a larger number of road-characteristics. (Fastenemeier, 1995; Marshall & Garrick, 2011). It was found that, out of all types of corrective feedback, indicating a desired behaviour was used most by driving instructors while driving through city areas. It is assumed that a majority of indicating correct behaviour was observed due to the larger number of tasks the driver has to perform in city areas. In rural areas, more gestures classified as corrective feedback were observed. Previous research stated that one major issue of the rural roads were the occurrence of fatigue (Wang, Quddus, & Ison, 2013). It can be argued that, due to the fact that directing the attention of the student was observed most, instructors used this type of corrective feedback during rural areas to counteract this phenomenon. Although the frequency is rather balanced, slightly more gestures classified as reflective feedback were observed while driving on highways. A majority of reflective feedback was presented in the form of reflecting on current situations. Most highways have multiple lanes in each direction (Fastenmeier, 1995). This leaves the driver with multiple options while driving, for example, deciding for a lane change or staying in the same lane. Hence, the outcome of the results can be explained by the driving instructor reflecting on the current situation and let the student decide of what to do.

4.2 Limitations of the Present Study

The reliability of the collected codes of both categorical variables was established using the inter-rater method. It turned out, however, that both coded variables have only weak levels of agreement according to the interpretation of the calculated Cohen's kappa values. One possible explanation for these low reliability values could be the language barrier which existed in the present study. The recorded conversations between driving instructors and students which played a crucial part in interpreting the meaning of the respective gestures of the instructors were in Dutch. However, compared to the second rater, the responsible researcher was not capable of speaking and understanding the Dutch language fluently which could explain some of the differences regarding the observed meanings behind the gestures.

4.3 Conclusion & Recommendations for Future Research

The aim of the present study was to give recommendations for a tutoring/feedback system to support first-time drivers of partially-automated cars in understanding its assistive devices and use them correctly. The frequencies of types of feedback used by driving instructors in different driving areas can be used to give recommendations for what type of feedback the system should provide in different driving areas. Results imply that the system should provide mostly corrective feedback in form of indicating correct behaviour in city areas. Feedback provided by the envisioned system in city areas could therefore look like this: “Assistive system take over steering and speed regulation, driver has to monitor”. The system should provide mostly corrective feedback in the form of directing attention to road characteristics in rural driving areas. Recommendation for this type of feedback provided by the system in rural areas could, for example look like this: “Intersection ahead, driver needs to take over in 10 seconds”. While driving on highways the tutoring/feedback system should provide more reflective feedback with the focus on reflection of current situation to help the driver to improve collaboration with the assistive systems. An example for a recommendation for the system in highway areas could therefore look like this: “Highway consisting of two lanes, let the car control the speed staying in the same lane or take over control to change lanes.”

However, the findings of the present study only give recommendations for what type of feedback should best be used by the envisioned tutoring/feedback system in different driving areas. The present study did not analyse how these types of corrective- or reflective feedback could best be adopted into instructions provided by the system (i.e. precise wording to use, which voice preferred etc.) nor the point in time of when to convey them to first-time users during the process of driving. Further research could therefore be conducted in the light of these issues.

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A. Appendix

A1. Appendix A: Background Chapter

The following section provides more information for the reader about the classification of automated cars and their implemented assistive systems as well as advantages and motivations behind the trend of automation and further feedback methods.

1. Automated Road Vehicle Classification

In order to classify automated cars the "Society of Automotive Engineers" (SAE) came up with a taxonomy in the form of a level framework for automated road vehicles, which they named SAE-scale (Tettamanti, Varga, & Szalay, 2016). In general, this scale ranks road vehicles based on their automation degree ranging from level 0, which implies no automation at all, to level 5 which equals a fully-automated road vehicle. The first level of the SAE-scale, which is named "Driving Assistance", represents all road vehicles with only one assistive device (Tettamanti, Varga, & Szalay, 2016). The second level of automation which is named "Partial Automation" is determined by *one or more* assistive devices taking over the tasks of steering, acceleration, and deceleration by using information from the environment of the road vehicle(Tettamanti, Varga, & Szalay, 2016). The driver, however, still has to perform the remaining driving tasks as well as the monitoring of his or her environment (Tettamanti, Varga, & Szalay, 2016). The third level of automation "Conditional Automation" of the SAE-scale describes road vehicles which handle all tasks necessary for driving but require the driver to take over in certain situations in a given amount of time (Tettamanti, Varga, & Szalay, 2016). The remaining two levels, level four known as "High-Automation" and level five known as "Full-Automation", are both categorised as fully automated (Tettamanti, Varga, & Szalay, 2016). In both levels, the automated road vehicle is able to handle all necessary driving tasks without the responsibility of the driver to intervene or take over in complex situations. The only difference between level four and level five of automation is that the fourth level automated vehicle can only operate in predetermined regions compared to the level five automation which is supposed to operate under all roadways and environmental conditions (Tettamanti, Varga, & Szalay, 2016).

2. Assistive Systems

Assistive devices or in-car systems, to which also this study's tutoring/feedback system counts, support the driver during his or her task of driving. These systems range from basic, more simple devices that only provide information to more advanced and complex systems taking over parts of the driving task themselves (van der Laan, Heino, & de Waard, 1997). An example for a simple, information-provision-only assistive device would be the radio which conveys news about weather circumstances or traffic (van der Laan et al., 1997). As examples for more advanced systems there are the Cruise Control (ACC) and the lane departure assistant help which allow for a better longitudinal and lateral control while driving and are already accessible for the general public (Eichelberger & McCartt, 2016; Naujoks et al., 2016). However, yet another type of these in-car systems can be found between these two extremes such as monitoring- and warning systems (van der Laan et al., 1997). Systems like these give feedback and support the driver in his task, therefore, the assistive device this study aims to invent the framework for can also be classified in this branch.

3. Advantages of Automation

The motivation behind creating more autonomous cars and other assistive technological devices, such as this study's tutoring/feedback systems is, for one, to increase the driver's safety. It is estimated that 93% of car crashes are due to human error and that, when automated cars become the majority on the streets, a reduction of car crashes of 50% to 90% is to be expected (Fagnant & Kockelman, 2015). The fact that no reduction of 100% is guaranteed shows that the technologies used are not perfected yet or not always understood correctly which explains the need for a tutor/feedback system.. An additional reason for the need of automation is that it was estimated that greenhouse gas emissions from transport vehicles could be reduced by half (Wadud, MacKenzie, & Leiby, 2016).

4. Further Feedback and Gestural Methods of Teaching

In the research of Hewson & Little (1998) recommended and non-recommended feedback techniques were presented. Examples of recommended behaviour of the feedback giver were being non-judgemental, respectful, and open-minded. On the contrary, non-recommended behaviour of the feedback giver were creating a threatening atmosphere by being judgmental, closed, and disrespectful

(Hewson & Little, 1998). Additionally, specific feedback which is focused on the behaviour and observed facts was recommended instead of providing general feedback focusing on personality or hearsays (Hewson & Little, 1998). Research found out that feedback which is provided frequently as well as immediately increases the learning effectiveness and learning engagement (Fui-Hoon Nah, Zeng, Rajasekhar Telaprolu, Padmanabhuni Ayyappa, & Eschenbrenner, 2014). Additionally, it was found that feedback is more effective if there is an appropriate interpersonal climate between the feedback supplier, as for example in the roles of teacher and student (Hewson & Little, 1998).