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Evaluation of the communication means of lateral driving dynamics at motorway slip roads

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Sofie Ehrhardt*[a], Daniel Graeber[a], Nadine-Rebecca Strelau[a], Barbara Deml[a]

Evaluation of the communication means of lateral driving dynamics at motorway slip roads

Abstract: The introduction of automated vehicles leads to a mixed traffic of automated and non-automated vehicles, which requires an understanding of the human driving behaviour. This work addresses the evaluation of two communication means on the motorway slip road from the perspective of drivers in the right lane. In a video study (N=68) two implicit communication means (position and duration of lane change) were investigated. The cooperation partner is either a manual vehicle or a car labelled as automated by an eHMI. The results show no significant differences between the cooperation and criticality ratings of non-automated or automated cooperation partners. A slow lane change is rated as less critical and more cooperative. A non-linear relationship emerges for the position of the change. A change in the middle of the slip road is rated most cooperative and least critical.

German Abstract: Die Einführung automatisierter Fahrzeuge führt zu einem gemischten Verkehr aus automatisierten und nicht automatisierten Fahrzeugen, was ein Verständnis des menschlichen Fahrverhaltens erfordert. Diese Arbeit befasst sich mit der Bewertung von zwei Kommunikationsmitteln auf dem Autobahnzubringer aus der Perspektive von Fahrern auf der rechten Fahrspur. In einer Videostudie (N=68) wurden zwei implizite Kommunikationsmittel (Position und Dauer des Fahrspurwechsels) untersucht. Bei dem Kooperationspartner handelt es sich entweder um ein manuelles Fahrzeug oder um ein Fahrzeug, das durch ein eHMI als automatisiert gekennzeichnet ist. Die Ergebnisse zeigen keine signifikanten Unterschiede zwischen den Kooperations- und Kritikalitätsbewertungen von nicht-automatisierten und automatisierten Kooperationspartnern. Ein langsamer Fahrspurwechsel wird als weniger kritisch und kooperativer eingestuft. Ein nichtlinearer Zusammenhang ergibt sich für die Position des Wechsels. Ein Wechsel in der Mitte des Fahrstreifens wird am kooperativsten und am wenigsten kritisch bewertet.

Keywords: automated driving, behaviour evaluation, user study, slip road;
Automatisiertes Fahren, Verhaltensbewertung, Nutzerstudie, Autobahnauffahrt

*Corresponding author: sofie.ehrhardt2@kit.edu

[a] Institut für Arbeitswissenschaft und Betriebsorganisation, Karlsruher Institut für Technologie, Engler-Bunte-Ring 4, 76131 Karlsruhe, Germany

1 Introduction

According to a study by Statista (2020), every one in ten vehicles will be driving autonomously in 2030. At the same time, 90 % of vehicles will only be partially automated or not automated at all. This results in mixed traffic of automated and manually controlled vehicles. In order to ensure safe and incident-free traffic, these vehicles will have to cooperate with each other. For this reason, there is a great need to understand human communication behaviour in road traffic and to develop concepts to transfer this behaviour to automated vehicles. The development of automated driving functions on the motorway is already rather advanced due to the comparatively lower complexity of the driving task compared to inner-city traffic. In 2021, for example, the first vehicle received certification for a SAE Level 3 function for the motorway driving mode (Mercedes-Benz, 2021). SAE level 3 is also referred to as "conditional driving automation" (ORAD, 2021) and includes the execution of all aspects of the driving task by an automated driving function. The driver still has to be able to take control at any time when requested. So far, automated driving is only possible on the motorway, not on the slip road. The latter, however, represents the more critical situation and is one of the most frequent causes of accidents and traffic jams on motorways (Kolen, 2013). Up to now, there has been a large gap in research on implicit communication behaviour at motorway slip roads and the evaluation of this behaviour by the cooperation partners.

Within this paper we present the results of an online study on how cooperative and critical different variations of lateral lane behaviour (duration and position of the lane change) are evaluated. In addition, it will be investigated whether the results can be transferred to communication with vehicles marked as automated.

2 Theoretical Background

Safe, incident-free traffic is based on constant communication between road users. Usually, the communication in traffic is short and directed, and can be well described by the Shannon-Weaver Model (Shannon & Weaver, 1949). The model is a universal communication model, which is particularly suitable for use in automated driving because the aspects of the model can be implemented by technical devices (Schaarschmidt et al., 2021). It states that a message is encoded by a transmitter and then received and decoded by a receiver. In between, noise can interrupt or distort the transmission of the signal. At a motorway slip road, the oncoming vehicle (transmitter) may express its intention to move to the right lane in the current gap by making a lateral movement (Felbel, Dattman, Lindner & Bullinger, 2021). The receiver, usually a vehicle on the right lane of the motorway, must first recognise this signal and comprehend it in addition. In between, factors such as rain or backlighting can distort the signal (noise). Automated vehicles would also be able to use their lateral position as a means of communication or register and interpret the movements of others via their sensor technology.

Schaarschmidt et al. (2021) provide an overview of the possible types of signals used in road traffic for communication purposes. The list refers to traffic in general, so not all of them are relevant to the situation of motorway slip roads. For example, the list includes physical gestures and eye contact, which do not play a role due to the speed on motorways. Relevant, on the other hand, are driving dynamics as a means of communication (Felbel et al., 2021). This includes acceleration, braking and tangential movements. In addition to the Shannon-Weaver-Model and the means of communication according to Schaarschmidt, communication in road traffic can be categorised into explicit and implicit communication (Langström & Lundgren, 2015; Imbsweiler et al., 2018). Explicit communication may include hand gestures or flashing lights. Implicit communication includes aspects of driving dynamics and requires more interpretation than explicit communication. In this paper, the focus is on the investigation of implicit communication through driving dynamics, especially through tangential movement.

Although a large research gap exists with regard to communication at motorway slip roads, more work has been done on lane changes on motorways. The motorway slip road is a special case of lane change as it is a forced lane change. Most other lane changes are unforced changes, for example during an overtaking manoeuvre (Choudhury, Ramanujam & Ben-Akiva, 2009). A driving simulator study investigated driving dynamics as a means of communication during unforced lane changes on motorways (Kauffmann, 2018). The influence of the start time of the indicator, the waiting time until the start of the lane change after setting the lane indicator and the speed during the lane change on the evaluation of the situation by the subjects was investigated. The results showed that longer duration of the lane change leads to a more positive evaluation of the cooperation. This effect was even larger when the indicator was used late before the lane change. However, no significant difference in the subjective ratings of criticality was found. The time at which the indicator was activated before the lane change was decisive for the assessment of criticality. On motorway slip roads, the indicator must be used from the beginning of the acceleration lane according to the German Highway Code and should therefore have no impact. For this reason, the aspect of the duration of the lane change is particularly relevant for this situation. In line with the findings of Kauffmann (2018) for unforced lane change, we assume that a slower lane change is also evaluated more cooperatively for forced lane change. In addition, we assume that a fast lane change is perceived as more critical because the influence of the indicator is not applicable.

Besides the duration of the lane change, the position could also influence the evaluation of the situation. The position where the lane change takes place has been investigated in previous studies only from the driver's perspective on the acceleration lane, not of the cooperation partner on the right lane. According to Marczak et al. (2013), the position of the driver on the acceleration lane is an important criterion for which gaps the driver rejects and which (s)he accepts. The closer the driver gets to the end, the more likely (s)he is to accept a smaller gap (Choudhury et al., 2009). This can cause vehicles in the target lane to decelerate or brake, increasing the effort required by the driver of the vehicle behind (Haar et al., 2022). Our hypothesis is, that a lane change at the end of the slip road is rated less cooperative and more critical than an earlier lane change.

For the modelling of the driving behaviour of automated vehicles, in addition to an understanding of human behaviour, it is important whether the expectations of the behaviour towards automated cooperation partners differ from those towards human cooperation partners. Therefore, influence of a labelling as an automated cooperation partner on the evaluation of the communication behaviour will be investigated. This labelling is provided by an external Human-Machine-Interface (eHMI) and comes, for instance, in the form of a light strip on the chassis (Schieben et al., 2019). The labelling is intended to increase the acceptance of automated vehicles in the event of norm-deviating behaviour (Maurer et al., 2015). It can include a function for explicit communication with other road users (e.g. through rhythmic flashing, cf. Schieben et al., 2019) or merely implicitly label a vehicle as automated (Joisten et al., 2019). An explicit eHMI has an influence on the interaction between the cooperation partners. Haar, Haeske, Kleen, Schmettow and Verwey (2022) investigated the influence of an explicit eHMI on a motorway in a driving simulator study. The signal of the indicator was modified in such a way that it also communicates whether a lane change is planned or imminent. They showed that the explicit eHMI increases the perceived cooperativeness of the two cooperating partners.

Studies regarding an implicit eHMI, on the other hand, find no significant effect on the behaviour or evaluation of other road users in inner-city traffic (Joisten et al., 2019; GATEway Project, 2017). Implicit eHMIs just indicate an automated driving mode to the environment but do not communicate further. In a study with pedestrians, a vehicle was labelled as automated or manual using an eHMI. The participants indicated when they would cross the road. The simple labelling without explicit communication did not result in a significant difference in behaviour (Joisten et al., 2019). The Gateway Project also concludes that a display does not influence the behaviour of other road users (GATEway Project, 2017). The aim of this study is to investigate whether the findings on implicit eHMI from inner-city traffic can be transferred to the situation of the motorway slip road. If an implicit eHMI does not induce differences in the assessment and behaviour of automated vehicles, other findings from traffic research should also be transferable to automated vehicles.

In this study, two questions will be investigated: *1. How are the two implicit driving dynamic communication means duration and position of lane change evaluated at a motorway slip road in terms of cooperation and criticality? 2. What influence does an eHMI have on the evaluation of the cooperation situation?*

3 Methods

The research questions were addressed in an online study using videos from the first-person perspective of a driver in the right lane. The following chapter describes the ~~procedure for creating the~~ video material and the methodological approach to data collection. ~~In a video study, two means of communication from the merging vehicle on the acceleration lane were visually represented. The view of a driver on the right lane is shown. A car changes from the acceleration lane to the right lane of the motorway, in front of the ego vehicle.~~ Three parameters are varied between the videos.

As the first independent variable, the duration of the change from the acceleration lane to the target lane was varied based on ~~the literature (~~Kaufmann, 2018~~)~~. In adaptation to the setting of a video study, fast to medium fast lane changes (2s, 4s or 6s) were made.

The second independent variable ~~varies~~ the position on the acceleration lane at which the merging vehicle has completed its lane change. The distance from the end of the acceleration lane is measured. Since an acceleration lane in Germany is usually 250m long, the distances chosen for the study are 0m (end of the acceleration lane), 100m (just past the middle of the acceleration lane) and 200m (just past the beginning of the acceleration lane).

Thirdly, the appearance of the oncoming vehicle ~~is~~ varied. In the baseline condition, a grey Audi A4 estate car (see Fig. 1) is chosen. A highly visible, surrounding turquoise light strip was added to this vehicle in half of the videos. The subjects were instructed that this eHMI indicates that the vehicle is driving in automated driving mode and is not controlled by a human. The design of the eHMI ~~is~~ adapted from Willbrink et al. (2021). ~~The driving situations shown in the videos were assessed by participants in an online video study.~~ The combination of variables resulted in a total of 18 (3x2x2) videos, which were presented to all participants in a within-subject-design. In addition, a sample video was recorded for the instruction of the subjects.

3.1 Materials

The videos were created using the Silab® driving simulator software. A motorway section with a slip road was generated in which various scenarios could be created. Figure 1 shows a screenshot of the scenario. The video shows the driver's perspective of a vehicle in the right lane of a motorway with three lanes in both directions. There is increased traffic density, with a speed of 120 km/h on the left lane and 100 km/h on the middle lane. Traffic in the right lane is travelling at 80 km/h. A heavy vehicle is visible in front of the driver's own vehicle. No other instruments or mirrors are displayed, the own speed is shown in the lower right corner. In all videos, the speed of the ego vehicle was kept constant at 80 km/h, the distance between the merging vehicle and the ego vehicle is always the same at the time of the vehicle's lane change in the acceleration lane. The distance to the heavy vehicle in front of the ego vehicle is also constant. The merging vehicle accelerates evenly from 50 km/h to 80 km/h in all videos. It reaches the speed of 80 km/h at the time when the lane change is completed. Since the lane change ends at different positions (0m, 100m, 200m before

Fig. 1: Screenshot from the sample video with an enlarged picture of the cooperation partner with eHMI.

the end of the acceleration lane), the acceleration is different in the three situations. As soon as the merging vehicle changed lanes, the ego vehicle decelerated to restore the safety distance. After deceleration, the vehicles accelerated again to 80 km/h. The length of the videos was 20 to 22 seconds, starting several meters before the acceleration lane and ending right behind the end of the acceleration lane.

3.2 Data Collection

Subjects filled out an online survey created by the tool LimeSurvey. The survey took about 15 minutes to complete. The subjects were recruited via the institute's subject database. As an incentive, three 20€ Amazon vouchers were randomly awarded to the participants. The requirement for participation in the study was the possession of a driving licence that allows the operation of passenger cars. Participants were instructed to complete the survey on a tablet or desktop computer and were not allowed to participate on smaller devices such as a mobile phone.

The survey began with a request for demographic information such as age, gender, years of holding a driving licence and driving experience (kilometres driven per year). In addition, the personal attitude towards automated driving was asked (-5 = very negative to 5 = very positive). The subjects were informed about the purpose of the study and the situation was introduced with a demo video. Following the demo video, the subjects had to indicate whether the merging vehicle in the video was an automated vehicle or not. This was to test the understanding of the function of the eHMI.

After the demo, the 18 videos were presented in randomised order. The videos could only be viewed once each, it was not possible to pause them. After each video, two questions were asked as described by Neukum & Krüger (2003). Question 1: "How cooperative was the driver on the acceleration lane?" and question 2: "How critical did you find the situation?". Question 1 was answered on a 10-point scale, which was divided into 5 categories. The categories used were very low (1-2), low (3-4), medium (5-6), high (7-8) and very high (9-10). Question 2 was answered on an 11-point ordinal scale from 0-10. The scale was divided into the categories: nothing noticed (0), noticeable (1-3), disruptive to driving (4-6) dangerous (7-9) and vehicle no longer controllable (10).

After the videos, the respondents were asked whether they had recognised the automated vehicles in each video. In addition, the question on the attitude towards automated driving was repeated. They were further asked if they expected a difference in behaviour between automated and manual vehicles. If this question was answered affirmatively, the participants were given the opportunity to name the expected differences in a free text field.

4 Results

The data set on which the analysis is based comprises 68 subjects (66% male). Inclusion criteria were the complete answering of the questionnaire, as well as the positive answer to the question whether the subjects hold a driving licence. In addition, nine subjects who answered incorrectly to the control question about automatization following the sample video were excluded. The demographic data are shown in Table 1. Participation in the study did not significantly change attitudes towards automated driving (t (67) = -0.12, p = .91). However, the attitude towards automated driving (pre study) correlates significantly with the age of the subjects (r = -.66, p < .01).

Table 1: Means and standard deviations of demographic data (N = 68)

Variable	*M*	*SD*
age	29.53	13.74
years of holding a driver's licence	5.74	5.17
driving experience (in km per year)	6671.03	8068.08
attitude towards automated driving (pre)	1.44	2.68
attitude towards automated driving (post)	1.46	2.63

Note. *M* and *SD* represent mean and standard deviation, respectively

During the evaluation of the three predictors (duration and position of lane change and eHMI), a systematic error in the video recording became apparent: In the condition of the fast lane change (2s) at the middle position (100m) without eHMI, the ego vehicle braked down significantly more than in the other videos, particularly the corresponding video with eHMI. Therefore, the eHMI factor is first considered separately. If the two videos in question are excluded from the analysis, there is no significant difference between the factor levels of eHMI for both criteria ($t_{Cooperation}$ (67) = 1.17, p = .245; $t_{criticality}$ (67) = -0.37, p = .716; see figure 2). Since the factor "eHMI" shows no significant effect and the systematic error occurs in the condition without eHMI, all following analyses refer to the videos with eHMI.

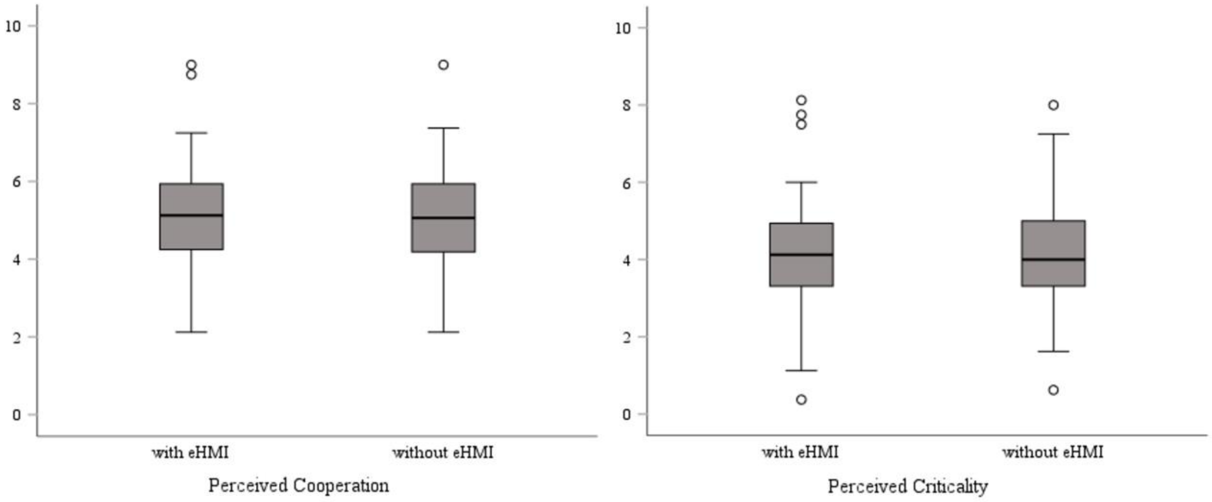

Fig. 2: Boxplots of the influence of the eHMI on the dependent variables.

The influence of the two means of communication (duration and position of lane change) on the two criterions "perceived cooperation" and "perceived criticality" is calculated with two two-factor ANOVAs with repeated measures. Violations of the sphericity are corrected with the Greenhouse-Geisser adjustment. The results of the analysis are shown in Table 2.

Table 2: Two-factor ANOVA with repeated measures with perceived cooperation and perceived criticality as the criteria

	Sum of Squares	*df*	df_{error}	Mean Square	*F*	*p*	partial η^2
Perceived cooperation							
duration	543.79	2.00	134.00	271.89	107.58	<.001	.62
position	144.33	1.63	109.19	88.56	24.127	<.001	.27
duration x position	124.34	4.00	268.00	31.09	14.81	<.001	.18
Perceived criticality							
duration	850.27	2.00	134.00	425.13	165.41	<.001	.71
position	206.83	1.79	120.10	115.39	37.81	<.001	.36
duration x position	164.28	3.57	238.83	46.09	18.05	<.001	.21

The main effect "duration of lane change" can be interpreted independently of the interaction effect for both criteria: a lower lane change leads to a more cooperative rating of the driving behaviour. The situation is assessed as less critical (see table 3). This effect is not dependent on the position of the lane change.

Table 3: Means and standard deviations of the perceived cooperation and criticality for the duration of lane change (N = 68)

Duration of lane change	Perceived cooperation			Perceived criticality		
	M	*SD*	Category	*M*	*SD*	Category
2s	3,74	1,48	low	5,90	1,63	disruptive
4s	5,37	1,64	medium	3,80	1,55	disruptive
6s	5,97	1,56	medium	3,14	1,45	noticeable

Note. *M* and *SD* represent mean and standard deviation, respectively. The categorisation corresponds to the categories proposed by Neukum & Krüger (2003), which were presented in the questionnaire next to the numerical response option.

The main effect "position of the lane change" can only be interpreted with regard to the interaction. For a fast lane change (2s), there is an almost linear relationship with the position: If it is performed early (with 200m distance to the end of the acceleration lane), it is evaluated as more cooperative and less critical than if it is performed shorter before the end of the acceleration lane. For a medium-fast (4s) and slow lane change (6s), however, there is an inverted U-shaped relationship with position: A lane change in the middle of the acceleration lane (100m) is rated as more cooperative and less critical than an early (200m) or late (0m) lane change (see Figure 3).

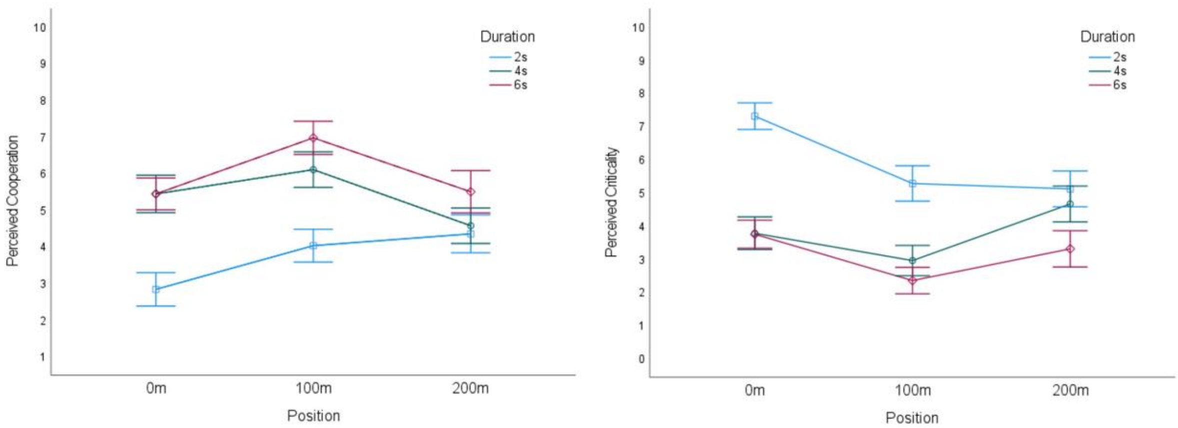

Fig. 3: Diagram of the influence of the position of lane change on the dependent variables.

In the post-questionnaire, 72 % of the subjects stated that they expect a different behaviour from automated vehicles compared to those controlled by humans. However, the reasons given are controversial: on the one hand, automated vehicles are expected to behave in a more optimised (19 out of 49 inputs) and predictable (14 out of 49) way, while on the other hand, automated vehicles are also expected to behave unexpectedly or to malfunction (11 out of 49).

5 Discussion

The results show no significant influence of the eHMI on the evaluation of the situation. In contrary, the duration as well as the position of the lane change significantly influence the evaluation. A slower lane change is perceived as more cooperative and less critical. In the case of a medium-fast and slow lane change, a change in the middle of the acceleration lane is preferred. A fast lane change is perceived as uncooperative and critical especially at the end of the acceleration lane. Thus, the results of our study are in line with the findings in the literature. The implicit eHMI has no significant influence on the evaluation of the interaction, comparable to the results of Joisten et al. (2019) and Schieben et al. (2019). This finding suggests that results from studies on the evaluation of human behaviour in road traffic can be used for the development of automated vehicles. A majority of the subjects in the follow-up survey state that they expect different behaviour from automated vehicles. However, the qualitative evaluations show that most test persons expect optimised and more predictable behaviour from automated vehicles, thus the absence of human errors. Results on the desired behaviour of manual cooperation partners should therefore also correspond to these requirements for optimised behaviour. The hypothesis that a faster lane change is perceived as more uncooperative and critical has also been confirmed. This result is consistent with previous findings from research on driving behaviour during an unforced lane change (Kauffmann et al., 2018). In contrast to the unforced lane change, in a motorway slip road the position of the lane change cannot be communicated by the direction indicator, as it is switched on throughout the acceleration lane. It is suspected that this is one of the reasons why the duration of the lane change is more relevant than in Kauffmann et al. (2018). Probably, a slow lane change on the motorway slip road is interpreted as an early communication of the intention to change lanes, similar to an early indicator in the case of an unforced lane change and is thus evaluated as more cooperative and less critical. A non-linear relationship is found between the position of the lane change and the evaluation: both an early lane change directly at the beginning of the acceleration lane and a late lane change at the end of the acceleration lane are evaluated as significantly more uncooperative and critical than one in the middle of the acceleration lane. However, this only applies in combination with a medium-fast or slow lane change. The more negative evaluation of the late lane change can be explained by the fact that the change at the end of the acceleration lane is considered as more enforced (Marczak et al., 2013). Due to the lack of alternative actions, the situation is perceived as more critical and less cooperative. An early change, on the other hand, may be perceived as more unexpected and thus more critical and less cooperative.

The present study is subject to some limitations. First, the results are based on the assessment of video recordings in an online survey. Some of the problems of this study format were countered with control questions. For example, records of subjects who did not correctly answer the question about the presence of eHMI in a test video were excluded. In addition, a minimum completion time for the questionnaire was set and replaying of the videos was prohibited. Studies also show that the perception of traffic situations in video studies is good (Imbsweiler, 2019). Nevertheless, the results should be replicated in a more realistic setting, such as a driving simulator study. A second limitation is the demographics of the sample: the average age of about 30 years is significantly below the population average. Furthermore, we found a negative correlation between age and attitudes towards automated driving. It is also interesting to note that although there is no significant difference in attitudes towards automated driving before and after the survey, the correlation with the age decreases: It is possible that a familiarisation with the topic can improve attitudes towards this especially among older respondents.

Thirdly, an error in the creation of a video without eHMI made the comparison between the conditions difficult. ~~Nevertheless, the results were in line with those expected from the literature.~~

In addition to validating the results in a realistic setting, future research should address other aspects of implicit communication at motorway entrances: According to the list of Schaarschmidt et al. (2021), the means of driving dynamic communication include lateral movement, which was analysed in the present study, as well as tangential movements (braking and accelerating). This aspect should receive more attention in future research.

6 Conclusion

From the evaluation of the two implicit driving dynamic communication means "duration" and "position of the lane change", specific recommendations for actions can be derived: The lane change should be performed slowly, as this is perceived as more cooperative and less critical. Furthermore, it should be carried out in the middle of the acceleration lane. This applies to both vehicles labelled as automated and conventional: No significant differences were found in the evaluation of the two types of vehicles. These findings can help to develop automated vehicles whose behaviour is understood and accepted by other road users. Also, the results indicate that in the tested scenario, labelling of automated vehicles has no added value for other road users.

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Figure 1

Click here to access/download;Figure (-.tiff: *graphs-1.200 dpi, halftone images-300 dpi*, -.eps, or -.jpg);Figure 1 Screenshot from video.jpg

Figure 2

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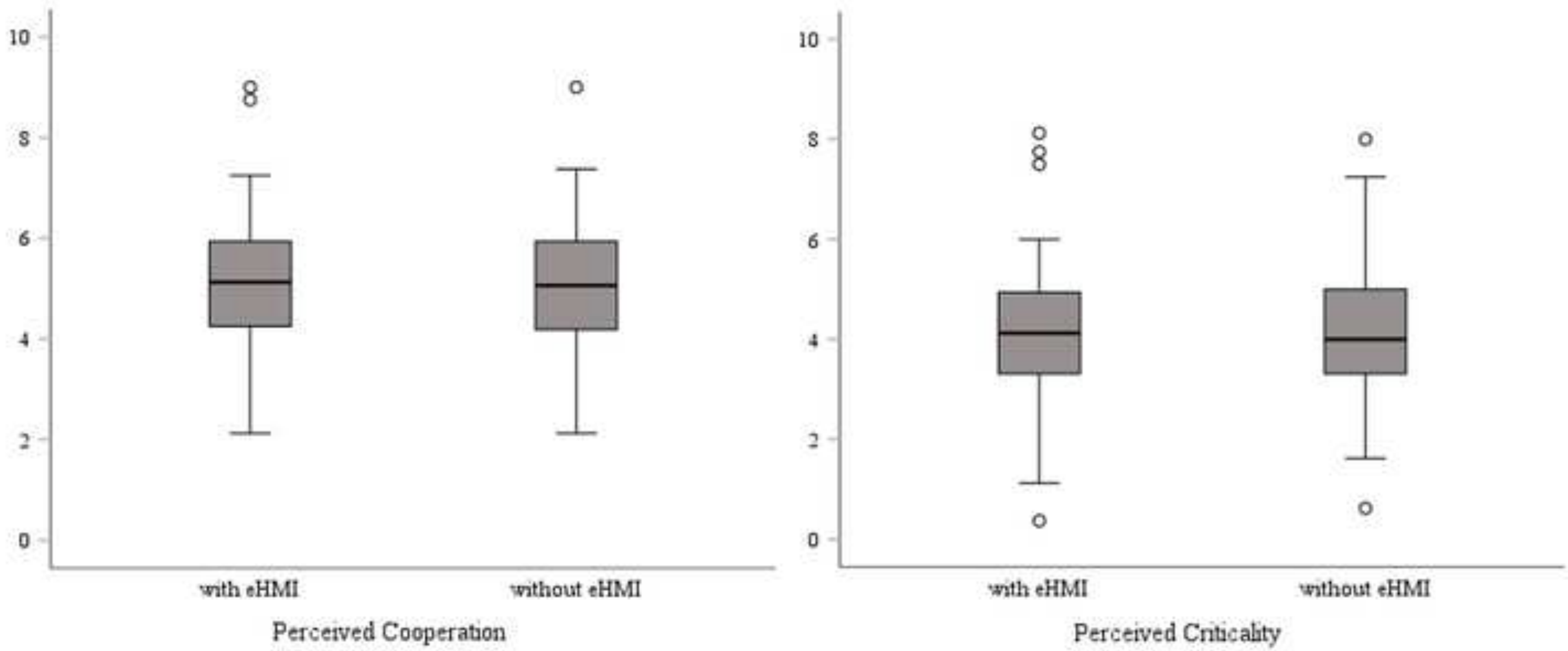

Figure 3

Click here to access/download;Figure (-.tiff: *graphs-1.200 dpi, halftone images-300 dpi*, -.eps, or -.jpg);Figure 3 Position of lane change.jpg

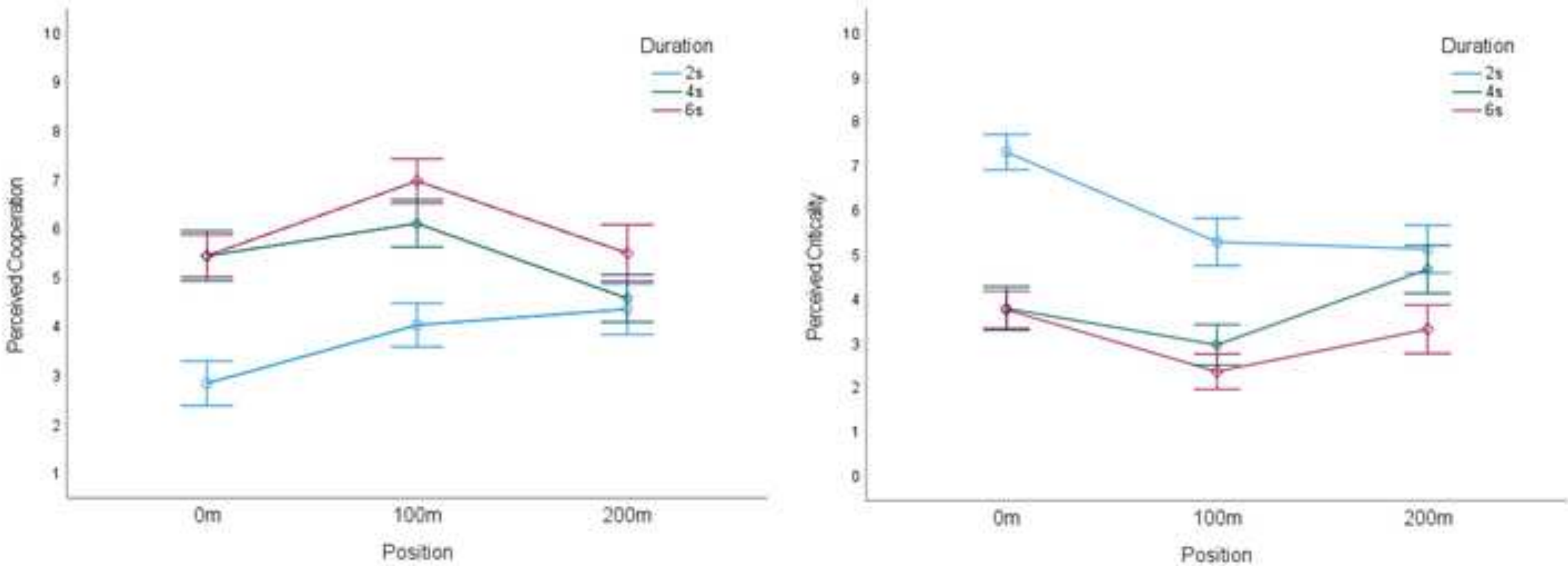

Table 1

Click here to access/download;Table;Table 1 Means and standard deviations of demographic data.png

Table 1: Means and standard deviations of demographic data (N = 68)

Variable	***M***	***SD***
age	29.53	13.74
years of holding a driver's licence	5.74	5.17
driving experience (in km per year)	6671.03	8068.08
attitude towards automated driving (pre)	1.44	2.68
attitude towards automated driving (post)	1.46	2.63

Note. *M* and *SD* represent mean and standard deviation, respectively

 Click here to access/download;Table;Table 2 Two-factor ANOVA with repeated measures.png

Table 2: Two-factor ANOVA with repeated measures with perceived cooperation and perceived criticality as the criteria

	Sum of Squares	***df***	***df**$_{error}$*	**Mean Square**	***F***	***p***	**partial η^2**
Perceived cooperation							
duration	543.79	2.00	134.00	271.89	107.58	<.001	.62
position	144.33	1.63	109.19	88.56	24.127	<.001	.27
duration x position	124.34	4.00	268.00	31.09	14.81	<.001	.18
Perceived criticality							
duration	850.27	2.00	134.00	425.13	165.41	<.001	.71
position	206.83	1.79	120.10	115.39	37.81	<.001	.36
duration x position	164.28	3.57	238.83	46.09	18.05	<.001	.21

 Click here to access/download;Table;Table 3 Means and sd of cooperation criticality.png

Table 3: Means and standard deviations of the perceived cooperation and criticality for the duration of lane change (N = 68)

Duration of lane change	Perceived cooperation			Perceived criticality		
	M	*SD*	Category	*M*	*SD*	Category
2s	3,74	1,48	low	5,90	1,63	disruptive
4s	5,37	1,64	medium	3,80	1,55	disruptive
6s	5,97	1,56	medium	3,14	1,45	noticeable

Note. *M* and *SD* represent mean and standard deviation, respectively. The categorisation corresponds to the categories proposed by Neukum & Krüger (2003), which were presented in the questionnaire next to the numerical response option.