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Drivers' adaption to automated vehicles in a longitudinal perspective

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Introduction

Automated vehicles (AVs) are an emerging technology on the road. However, before the traffic consists entirely of automated vehicles, we will experience a long period of mixed traffic where automated vehicles will coexist with human drivers.

Automated vehicles are supposed to behave anticipatory, defensive, and rule-compliant, and are thus expected to make traffic both safer and more efficient. However, this positive effect on traffic will only occur when human drivers also behave this way. This rises questions whether drivers will adapt their behaviour to those of automated vehicles, and whether automated vehicles can serve as role models for human drivers.

Findings of previous studies suggest that the extent and the direction of drivers' behaviour adaptation as well as their general perception of mixed traffic are not yet clear. Drivers might assimilate, increased or decreased their time-headways (Guoy et al., 2014; Aramrattana et al., 2022) or might even see automated vehicles as obstacles that decrease efficiency, comfort, and safety (Stange et al., 2022). However, those studies have in common that they examined drivers' reaction in a single session study, that is, rather as first contact interaction. However, as mixed traffic will occur for a longer period, it is reasonable that drivers' behaviour adaptation may occur or change over time and over the course of multiple interactions.

Therefore, in our study we aim to examine potential behaviour adaptation of human drivers in a longitudinal perspective, that is, with participant experiencing mixed traffic in several sessions. Additionally, we will examine the effect of marking the automated vehicles. Our study design will allow us to identify whether human drivers behave differently when being surrounded by automated vehicles and whether this behaviour adaption will develop over time. Furthermore, we might derive recommendations how to influence driving behaviour of human drivers.

Research methodology

We plan a longitudinal study in our driving simulator at the Department of Traffic and Engineering Psychology at the Technische Universität Braunschweig. In seven sessions over a period of about seven weeks participants will drive manually on a highway for about one hour. In the first session they will experience manual driven vehicles only, so that this drive can serve as baseline. In the other six sessions, participants will drive in mixed traffic with about 40% autonomous vehicles.

As additional between-subject factor, we will vary the marking of the autonomous vehicles. One group of participants will be informed about the presence of autonomous vehicles and the autonomous vehicles will be marked as such, another group are also informed but the autonomous vehicles are not marked, and the last group is not at all informed about the presence of autonomous vehicles.
As at least in Germany, mixed traffic will firstly occur on the highway, we will focus on highway scenarios only. Thus, we are interested in the participants' (EGO) driving behaviour when a) on-ramp merging of the EGO, b) lane change by the EGO, c) lane change by AV in front of EGO, and d) braking of AV in front of EGO due to speed limit ahead.
To ensure a sufficient high occurrence of these scenarios, we implemented a few on-ramps, slower trucks on the right lane that the participants can overtake, and various speed limit sections with either no limit, 120 km/h, 100 km/h, or 80 km/h.
After each drive participants will be asked to evaluate the traffic and interaction with the other vehicles in terms of mental stress, comfort, efficiency, and dangerous or unpleasant situations. Furthermore, the driving simulator records the participants' driving behaviour such as speed, braking or time-headways.

Results

If the presence of automated vehicles in traffic indeed has an effect, we expect drivers to adapt their driving behaviour to those of AVs. This will be represented by less speed volatility, similar time-headways, and more rule compliance especially in the speed limit sections.
Regarding the subjective evaluation, we expect drivers to experience driving as less stressful, more relaxing and more efficient.

Discussion and conclusions

Results will provide valuable insights on human drivers' behaviour adaption when being surrounded by automated vehicles. The longitudinal study design allows are more realistic examination of the development of potential behavioural adaptation. More specifically, findings will indicate whether human drivers will at all adapt their behaviour in mixed traffic and whether automated vehicles in particular may serve as role models. Beside this, the results cover drivers' opinion about the marking of automated vehicles and their driving behaviour in general. This will help to draw conclusion on how future mixed traffic shall be realized to be comfortable for human drivers.

References

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