TECHNISCHE UNIVERSITÄT CHEMNITZ

ALLGEMEINE UND ARBEITSPSYCHOLOGIE TU CHEMNITZ

Steering only at low speeds – how do drivers cope with giving up longitudinal control?

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Abstract

Battery Electric Vehicles (BEV) in combination with automation technology bear considerable potential in addressing ecological and safety issues in road traffic. In our study we examined the driver interaction with a BEV featuring a *Wizard-Of-Oz* that controlled acceleration and deceleration. We interviewed the participants and investigated driver trust and comfort when interacting with the automation. As behavioural response we examined if and when drivers utilized the brake to overrule the automation. Furthermore, we studied if such take over requests relate to personality traits such as sensation seeking and locus of control. Forty drivers (19 female, 21 male) with an average age of 31 years took part in the experiment. The study featured a within subject design with the factors manoeuvre (*straight vs. curve*), the occurrence of pedestrians (*pedestrian vs. no pedestrian*) and automation level (*baseline [no automation] vs. automation 20 km/h vs. automation 35 km/h*). In the accompanying interviews participants expressed interest and sympathy for the automation technology, but also mentioned concerns related to the reliability of automated systems. Initial findings indicate increasing stress levels at 35 km/h and higher subjective workload in curves. How braking behaviour relates to personality traits will be discussed to infer recommendations for automated systems.

Method

Participants

- N = 40 drivers
- N = 19 female, N = 21 male; M_{age} = 31 years (SD = 6)
- Mean number of kilometers travelled in previous year = 16.000
- No experience with automated cars

Experimental Design

- Within-subject design; balanced order

Independent variables

- maneuver (straight vs. curve)
- occurrence of pedestrians (pedestrian vs. no pedestrian)
- automation level (baseline vs. 20 km/h vs. 35 km/h)

Assisting function: Wizard-of-Oz

- Function regulates longitudinal control including starting and stopping
- Function recognizes stopping point and pedestrians
- Overruling through brake pedal usage is possible at all times

Dependent Variables

- Subjective assessments: acceptance ([1]; trust [2,3], stress
- Logger data / video data: manual takeover (braking)

Procedure

- 1. Familiarization drive in real traffic (20 min)
- 2. Test drive on test track with 4 scenarios at different speeds (baseline, 20 km/h, 35 km/h) (see Figure 1)
- Task: Steering and – only if necessary – braking

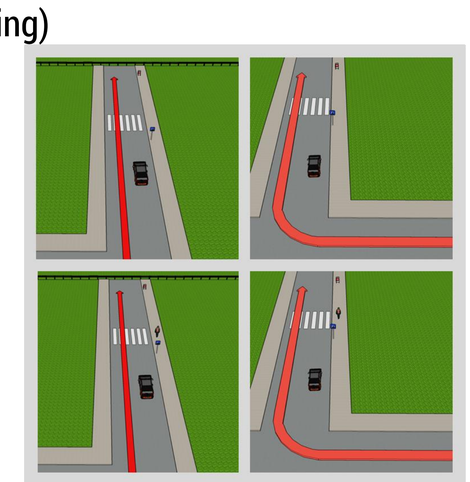

Figure 1. Test scenarios.

Results

Subjective evaluation

- **Trust:** significant increase (pre vs. post assessment) (Fig. 2)
  $t(39) = -7.23$, $p < .001$, $d = 1.16$
- **Discomfort:**

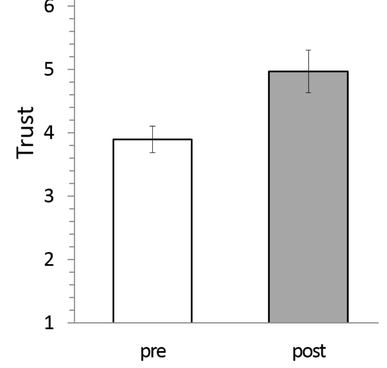

Figure 2. Trust

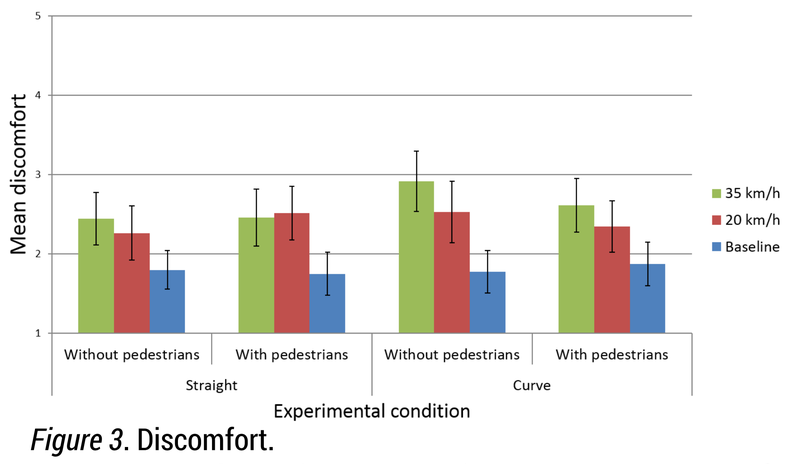

Figure 3. Discomfort.

ME automation: $F(1.34, 46.78) = 20.23$, $p < .001$, $\eta_p^2 = .37$; ME maneuver: $F(1, 35) = 15.51$, $p < .001$, $\eta_p^2 = .31$; IE automation x maneuver x pedestrian: $F(2, 70) = 4.19$, $p = .019$, $\eta_p^2 = .11$

Video data

- **Braking participants:**

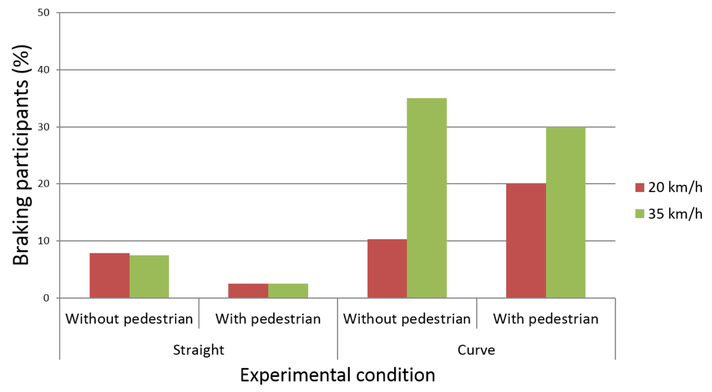

Figure 4. Brake pedal usage.

Personality traits

- Sensation seeking & number of brake reactions: r = - .03 (ns)
- External locus of control & number of brake reactions: r = - .14 (ns)
- Internal locus of control & number of brake reactions: r = .05 (ns)

Conclusions

- Results revealed higher trust ratings after experiencing the function. Such an increase replicates findings on trust in other innovations [4].
- Especially in curves discomfort ratings were higher in the 35 km/h condition. The presence of pedestrians played a minor role in the evaluation.
- Brake reactions tended to occur in curves and particularly at 35 km/h. This indicates that 35 km/h might have been too dynamic/fast for one third of the participants.
- Personality traits such as sensation seeking and locus of control are not related to the tendency to override the system through brake pedal usage.

References:
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[2] Jian, J. Y., Bisantz, A. M., & Drury, C. G. (2000). Foundations for an empirically determined scale of trust in automated systems. *International Journal of Cognitive Ergonomics, 4*(1), 53-71.
[3] Beggiato, M., & Krems, J. F. (2013). The evolution of mental model, trust and acceptance of adaptive cruise control in relation to initial information. *Transportation research part F: Traffic Psychology and Behaviour*, *18*, 47-57. dx.doi.org/10.1016/j.trf.2012.12.006
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NeMoS

Open-air lab 'New Mobility' at Sachsenring (NeMoS) [Freiluftlabor 'Neue Mobilität' am Sachsenring]

The project is one of forty other projects investigating electric mobility embedded in the German 'Showcase Regions for Electric Mobility' (electromobility connects [Elektromobilität verbindet]). In the test environment of the Sachsenring-circuit a consortium of partners from industry and academia wants to investigate the safety, reliability, use, user acceptance and also the economy of electric vehicles.

NeMoS project team with electric test vehicles.

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