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# Assessing complacency in critical driving situations for automated vehicle guidance

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## Introduction

In highly automated driving applications, the driver needs to be able to **regain manual control** in critical driving situations (NHTSA, 2013). However, this transition to manual driving predominantly results in **prolonged reaction times** (De Waard et al., 1999) or **collisions** with preceding obstacles (Saxby et al., 2013). In highly automated driving conditions, **complacency** plays an important role as the system is highly reliable and the driver will be dealing with competing secondary tasks (Manzey & Bahner, 2005).

## Method

### Participants

- $N$ = 48 drivers ($n$ = 32 men, $n$ = 16 women)
- $M_{age}$ = 24.48 years ($SD_{age}$ = 4.36 years)

### Experimental Design

- 2x3 Mixed-design
- *Between factor:* critical scenario (braking truck, broke-down car)
- *Within factor:* automation level (manual, automated-highly reliable, automated-low reliable)

*Figure 1*: Driving simulator.

*Figure 2*: Critical scenarios.

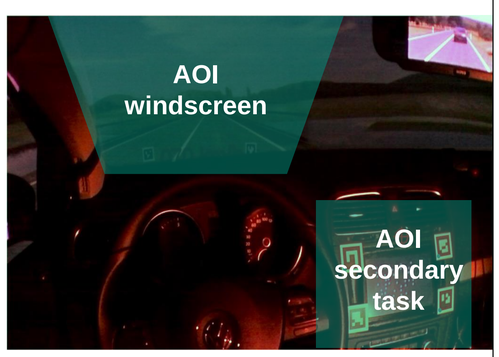


*Figure 3*: AOI definitions.

### Dependent Variables

- *Subjective Measures:* Trust, Distrust, Mental Workload, Immersion, Fatigue
- *Secondary Task Measures (SuRT):* number of completed tasks, mean time per task, number of errors
- *Driving parameters:* collisions, $TTC_{br}$, $TTC_{min}$, reaction time to the critical scenario
- *Eye-Tracking measures:* number of fixations on both AOI's "windscreen" and "secondary task", cumulative fixation time on both AOI's

## Results

### Driving Parameters

- 51.1 % of all subjects *expected* the system not to work in the low reliable automated mode

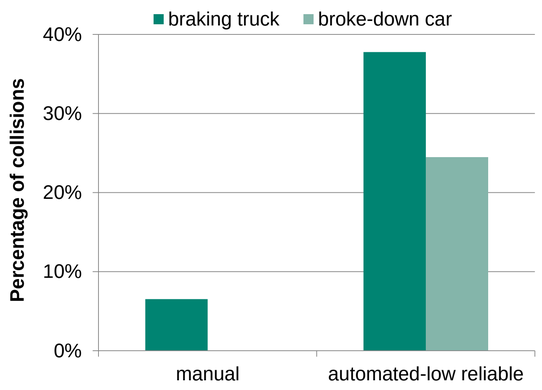


*Figure 4*: Collisions in critical scenarios.

### Subjective Measures

- *Trust* decreases significantly in low-reliable automation after experiencing highly-reliable automation ($t(46) = 5.31$, $p < .001$, $d = 1.08$)

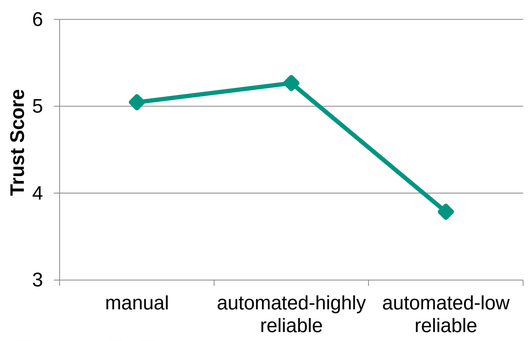


*Figure 5*: Trust ratings.

### Eye-Tracking Measures

- The differences in *cumulative fixation times* between manual and both automated levels were significant at all time intervals ($p < .001$)

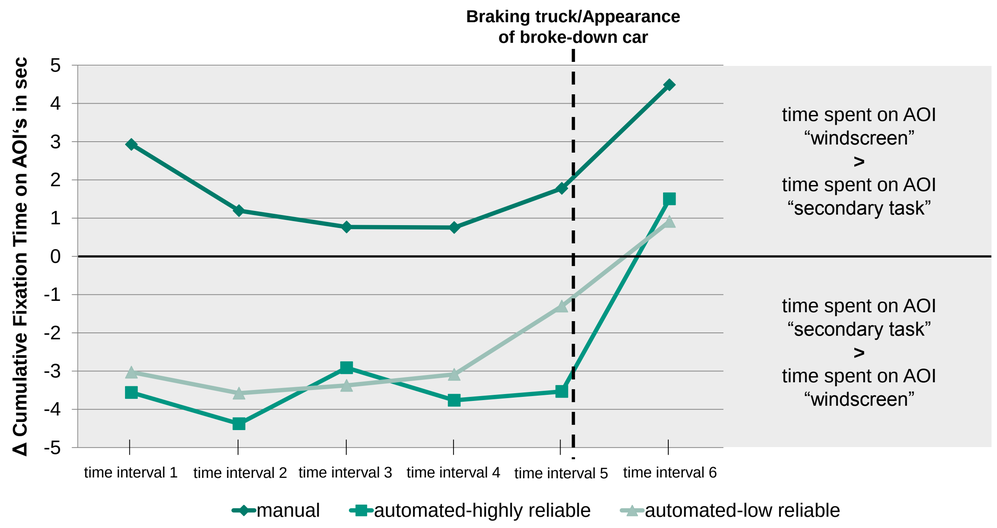


*Figure 6*: Monitoring behavior in both critical scenarios. Each time interval covers approx. 6.7 sec.

## Conclusions

Drivers **fail to regain manual** control in automated mode after the appearance of a critical driving scenario as a consequence of **inadequate monitoring behavior**. Secondary task performance as well as eye movement data implies that participants show high levels of **complacency in automated driving** in comparison to the manual driving condition. Continuously presented **feedback** which is peripherally detectable might support drivers to relocate attention to the windscreen.

## References

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