

How does trust in vehicle automation affect the handover process? A Wizard-of-Oz study on public roads

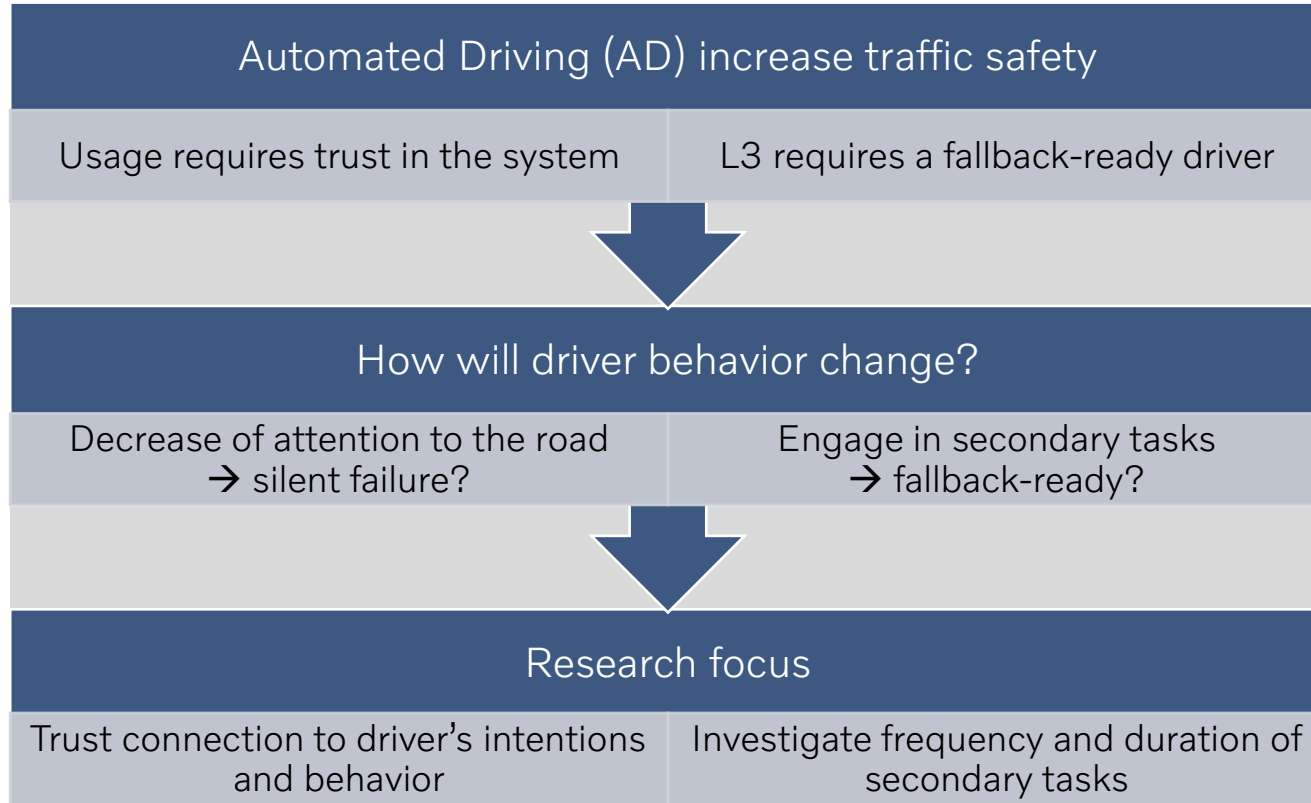
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Motivation and Research Questions



RQs in L3Pilot:

What is the perceived trust in the Automated Driving (AD)?

What is the effect of AD use on driver attention to the road/other road users?

What is drivers' secondary task engagement during AD use?

Method

Wizard-of-Oz setup to experience AD on public roads with normal drivers

- Modified Volvo XC90 with double controls in the rear center (drive by wire)
- 3 cameras to observe driver behavior
- 30 participants (10 female) from VCC with age ranging from 23 to 64 ($M=39.2$, $SD=10.5$)



Method – Procedure



The public roads selected for pilot testing: a) Map of the selected segments on the Gothenburg ring road (dashed lines) with AD available sections marked in blue, b) forward facing camera view from a test vehicle.

Slingan, Göteborg

- City motorway environment around Gothenburg, Sweden (2-3 lanes, center separated, speed limit 70-80 km/h)
- Driving 2 laps clockwise (app. 1 hour drive)
- Wizard introduced as backup driver for safety
- AD mode – wizard drives (can use ACC)

Method – Test design



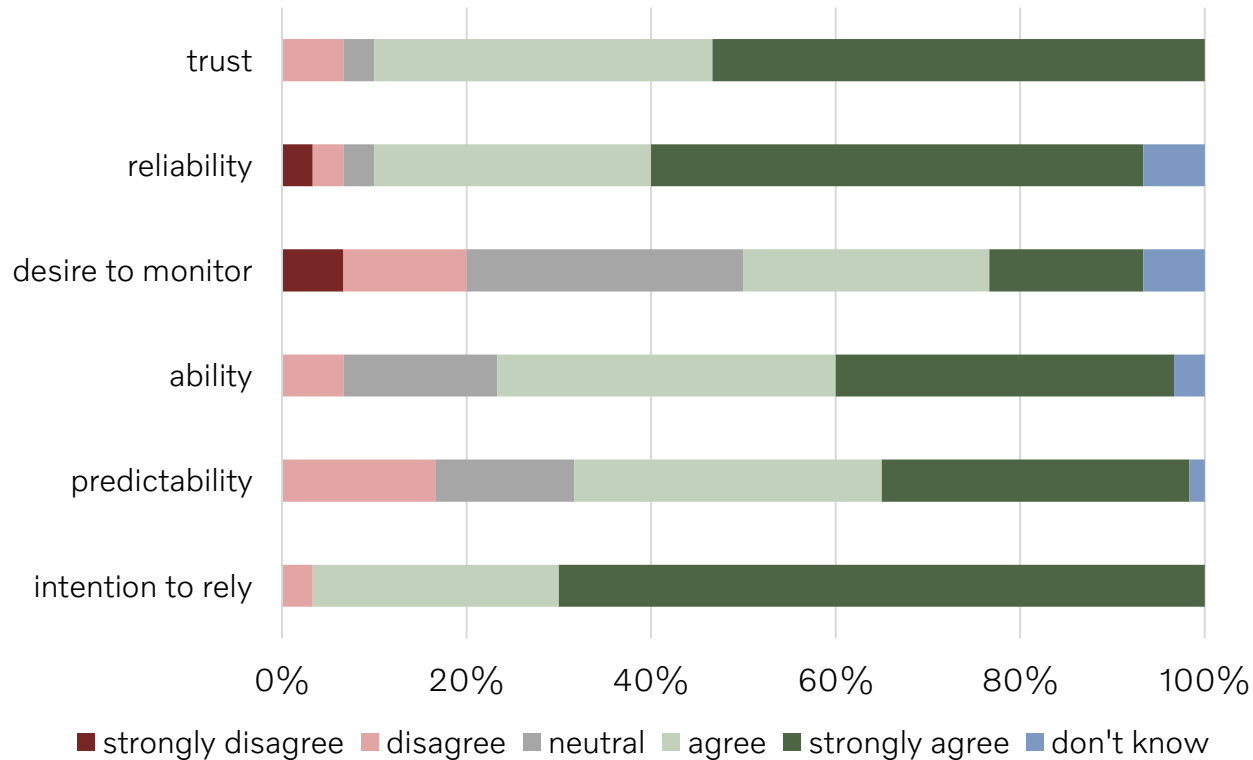
AD available triggered by test leader

- Short test phase (app. 1 min)
- Two main phases (app. 5-6 min) per lap
- Non-driving related tasks explicitly allowed during AD
- Tablet mounted in center stack available to use

Measures

- Questionnaire trust-related items (reliability, ability, predictability, intention to rely, desire to monitor)
- Video annotations of hand-over process (first glance display, AD activation, hands off wheel, feet resting position, start secondary task)

Results – Trust-related questionnaire items



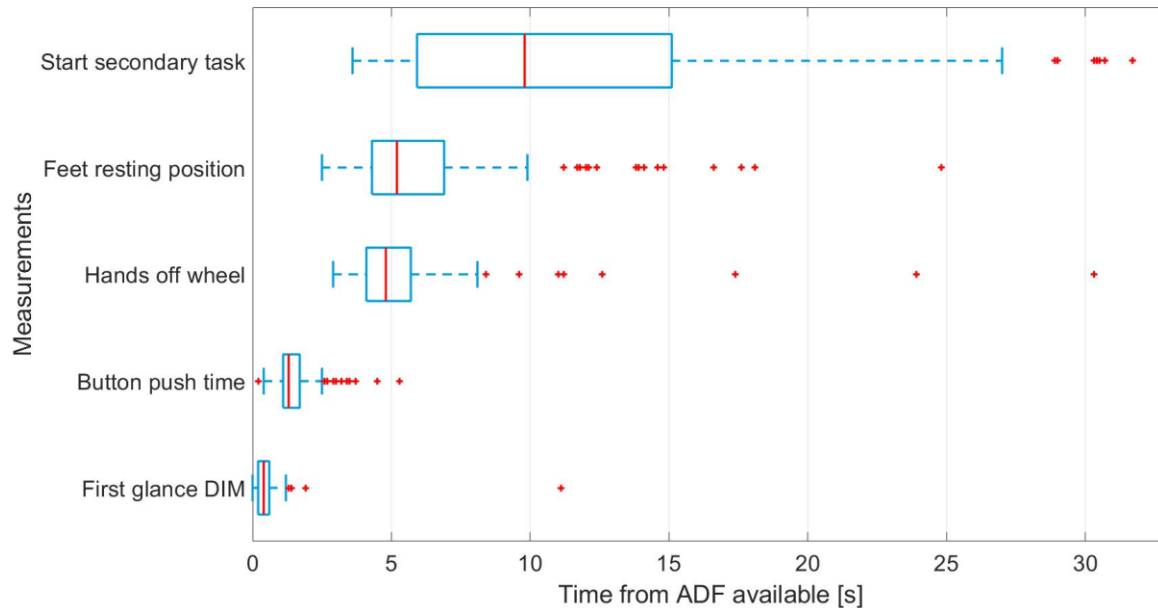
- Predominantly positive assessment
- High trust, reliability and intention to rely
- Slightly lower *predictability*
- High *desire to monitor* seems counterintuitive (halo effect)

Results – Trust-related questionnaire items correlation

Items	Intention to rely	Predictability	Ability	Desire to monitor	Reliability
Predictability	0.14				
Ability	0.52	0.24			
Desire to monitor	-0.1	-0.03	-0.03		
Reliability	0.39	0.43	0.46	-0.06	
Trust	0.45	0.27	0.31	0.27	0.53

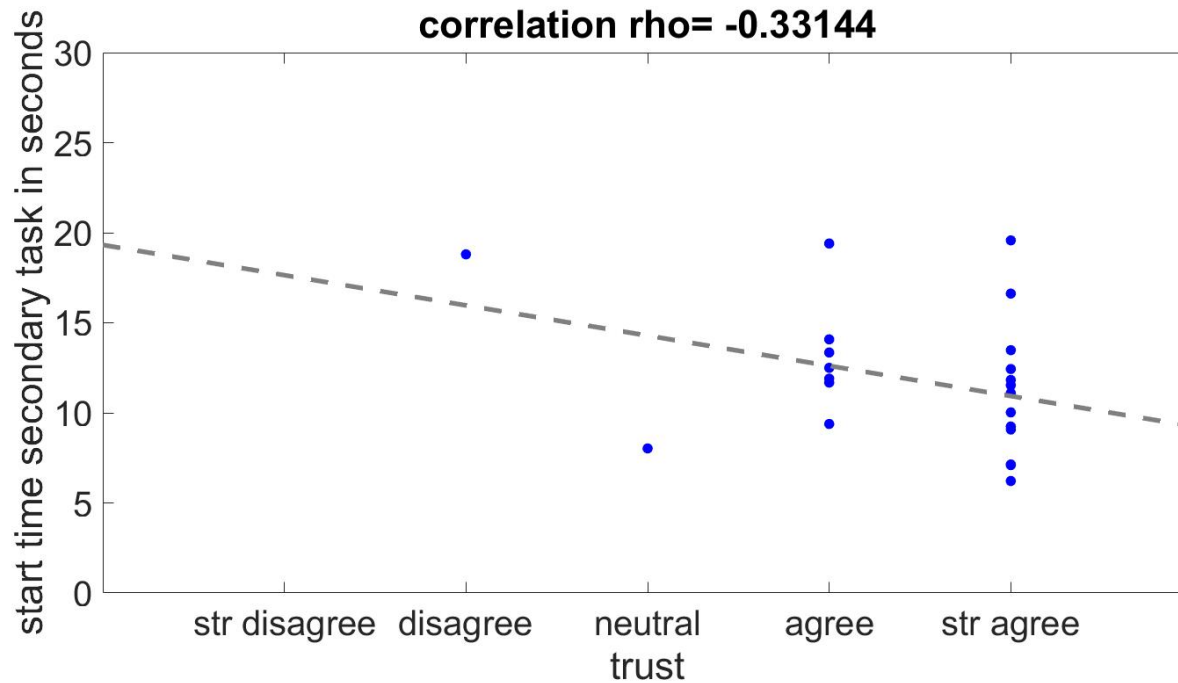
- Moderate to weak correlation of all items with trust
- *Desire to monitor* only correlates to *Trust*

Results – Hand-over process



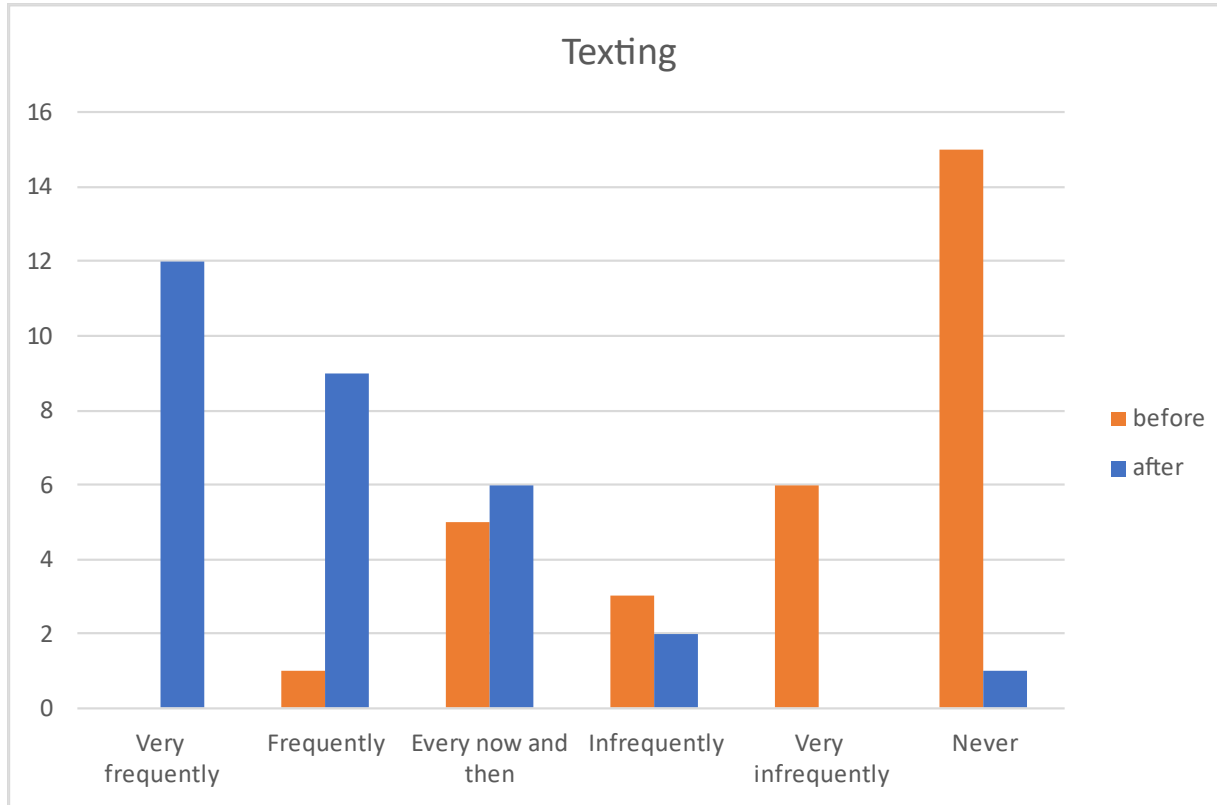
- Glance towards driver information monitor (DIM) within 2 seconds (95-percentile)
- System activation immediately after
- Hands off wheel on average after 5-6 seconds
- Majority starts secondary task within 30 seconds after system availability

Results – connection of trust with behavior



Trust level correlates with time until engagement into secondary task

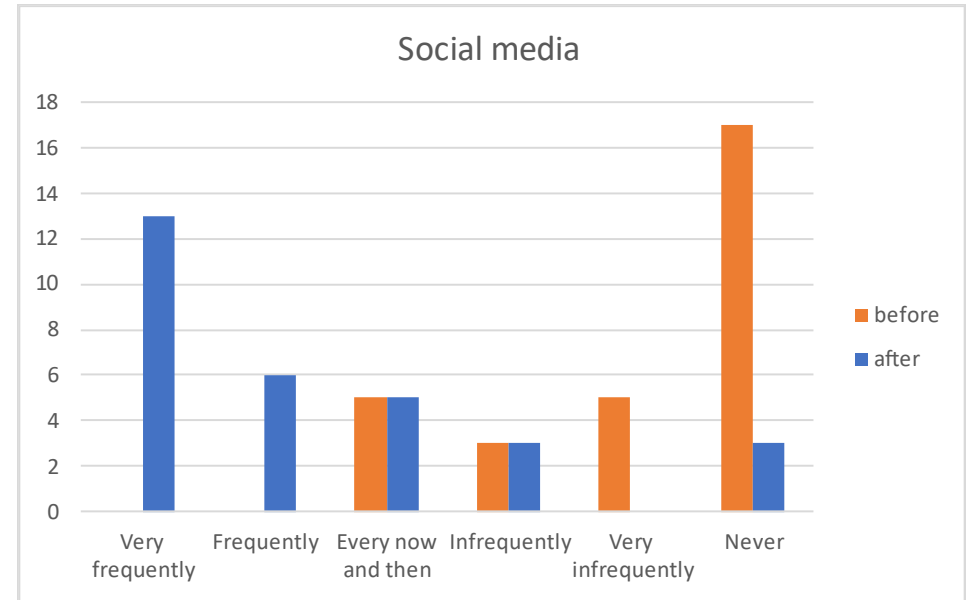
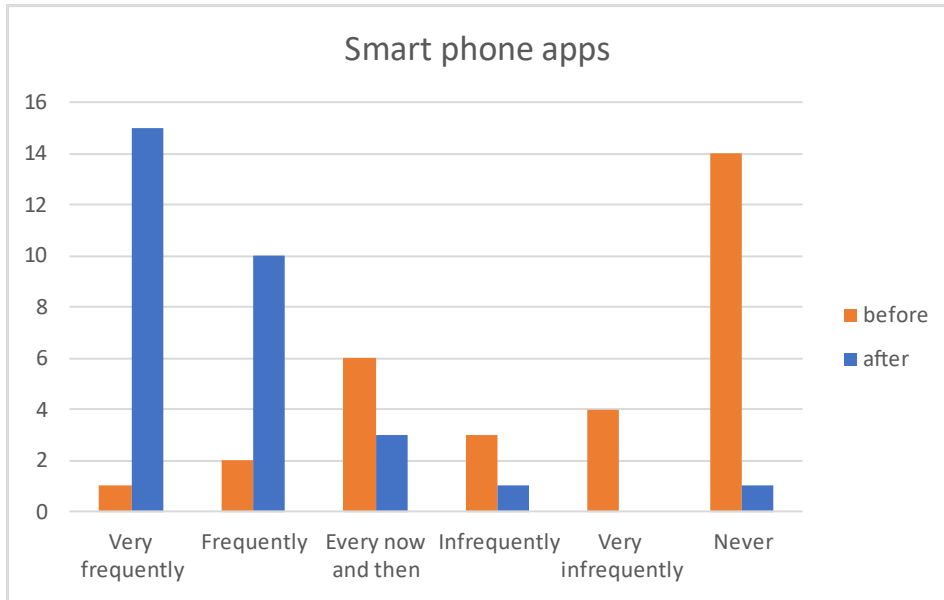
Results – self-reported behavior (texting)



Only 50% report not to text while driving

Clear shift expected when introducing AD

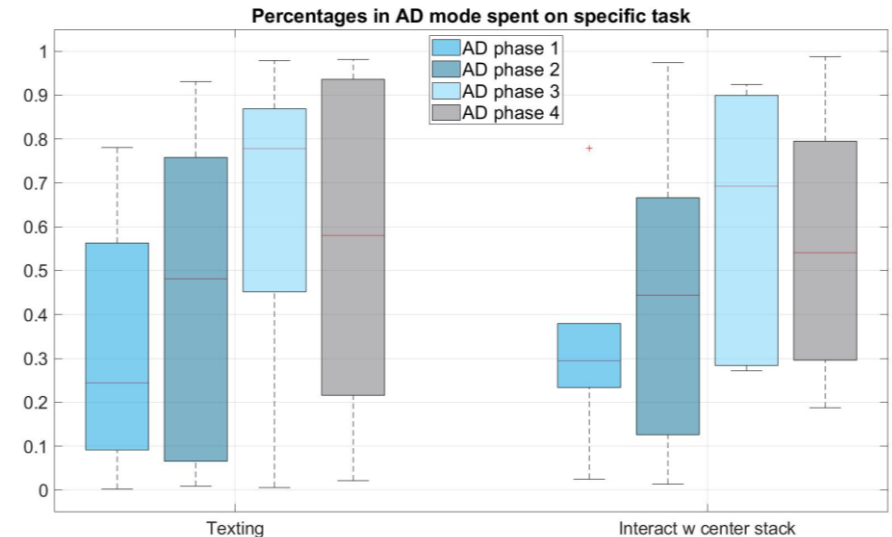
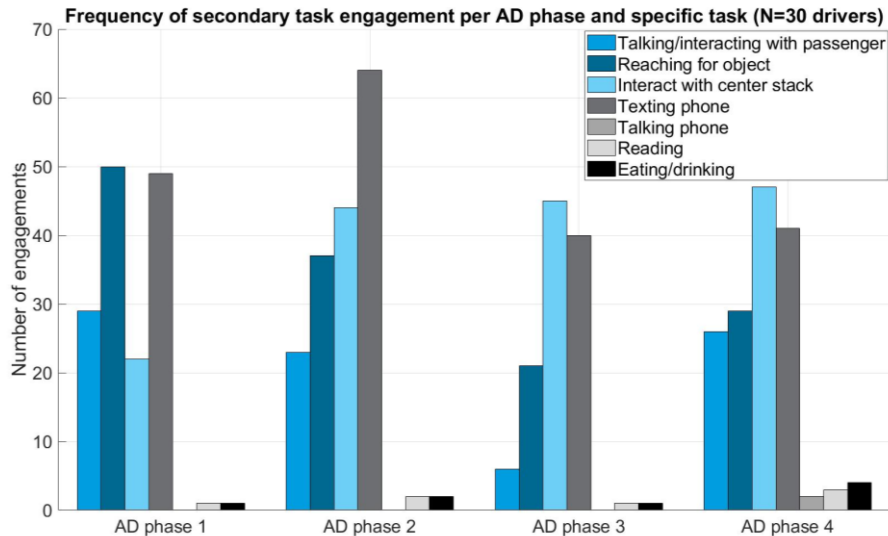
Results – self-reported behavior (smart phone usage)



Results – frequency and duration secondary tasks

Majority of driver (87%) engage in secondary tasks – predominantly texting with the phone or interacting with the center stack (mounted tablet)

Duration of texting increases over 3 AD phases up to 65% in average



Conclusions

Trust in AD

- High levels of trust
- Fast activation (avg 2 seconds to activation)
- Hand-over process smooth and quick

Behavior

- Majority engaged in secondary tasks (mainly texting and using the tablet)
- Self-report confirms intention to increase phone usage (texting, browsing, etc.)



V O L V O



Thank you for your attention.

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