Ambient light based interaction concept for an integrative driver assistance system

EU Project AdaptIVe

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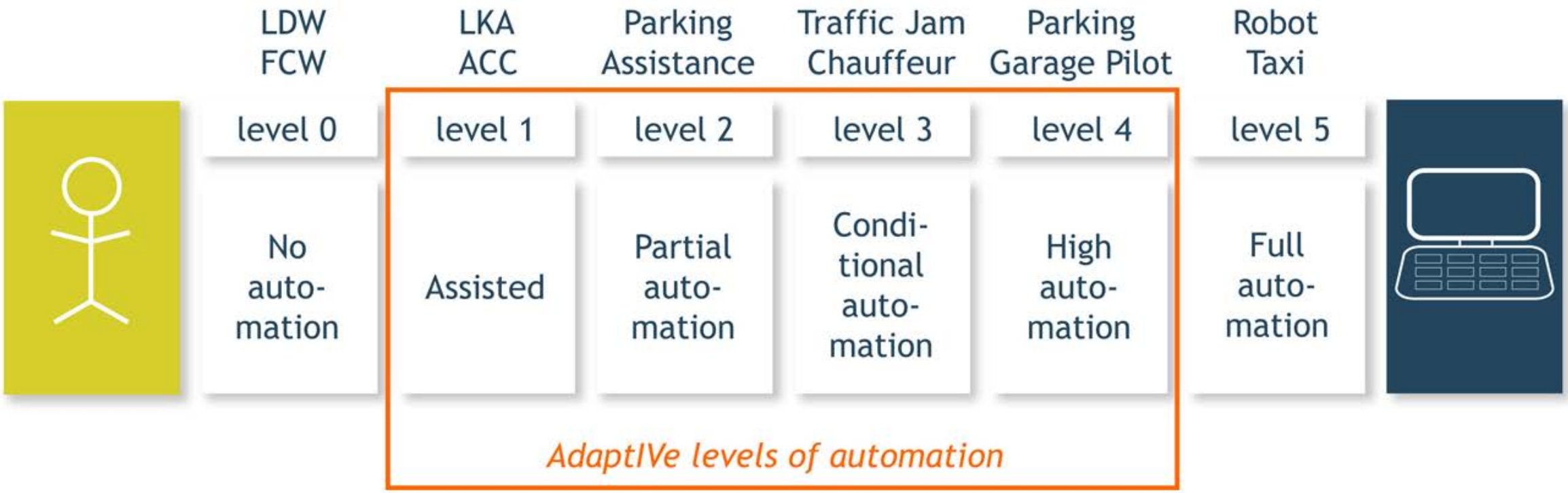
AdaptIVe
Automated Driving

Budget:	25 Million EUR
European Commission:	14,3 Million EUR
Duration:	42 months (January 2014 – June 2017)
Coordinator:	Aria Etemad, Volkswagen Group Research
28 Partner:	France, Germany, Greece, Italy, UK Spain, The Netherlands, Sweden

Levels of automation in AdaptIVe

SAE



SAE document J3016, “Taxonomy and Definitions for Terms Related to On-Road Automated Motor Vehicles”, issued 2014-01-16

Motivation:

- Highly automated driving requires reliable sensor data
- If sensors deliver doubtful information or traffic situations were unclear

≠ 100% confidence

Give the control to the driver

Lower acceptance by to frequent transitions of control

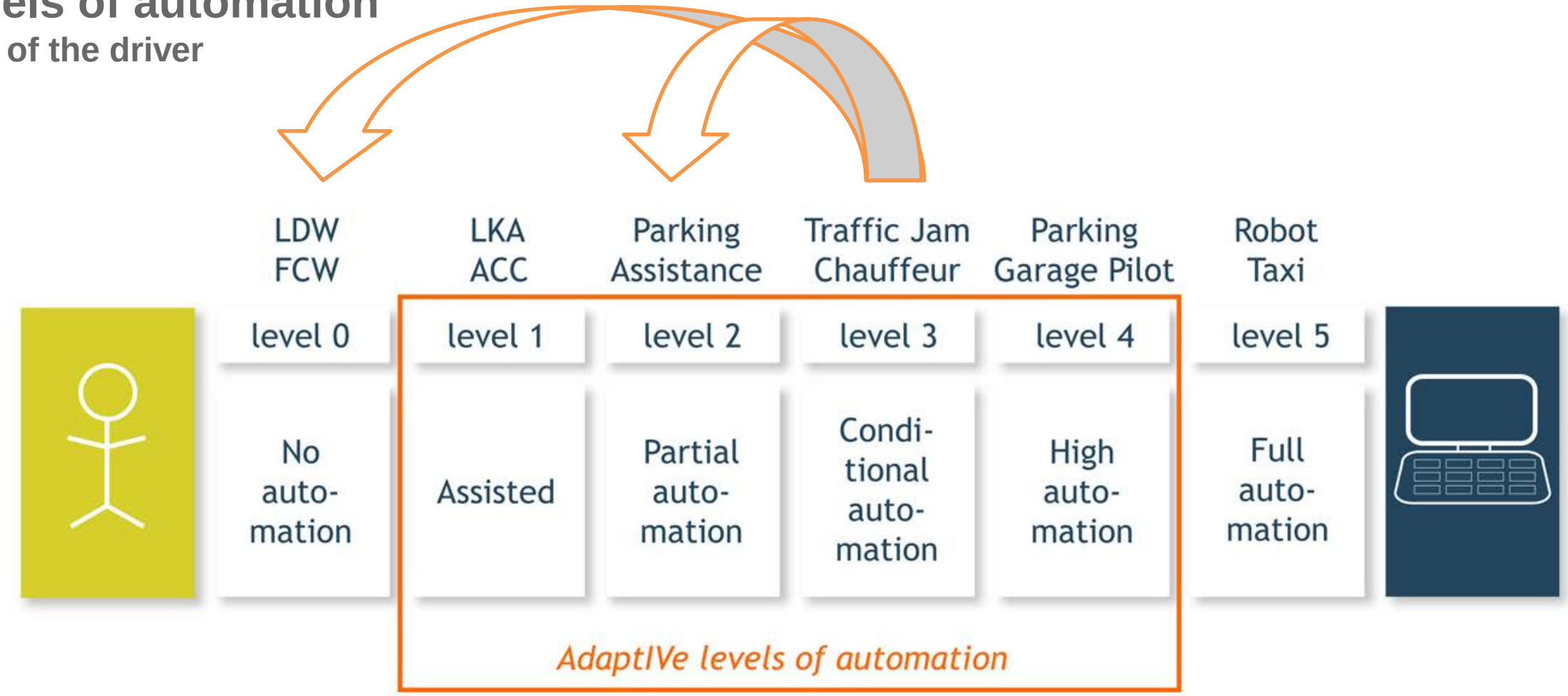
Involve driver in monitoring

Transition of control not always necessary

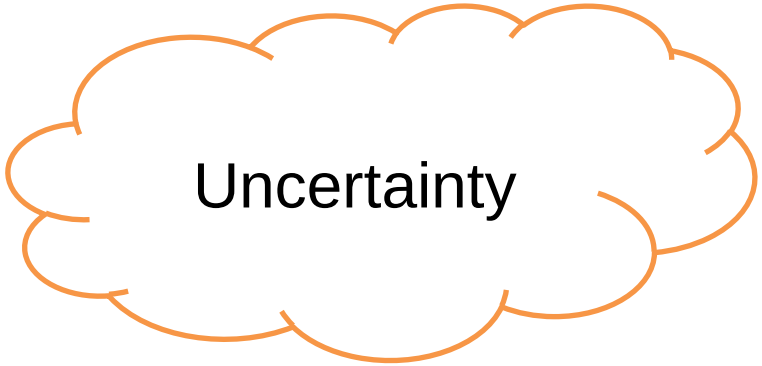
Higher acceptance due to fewer transitions of control

Levels of automation

Role of the driver

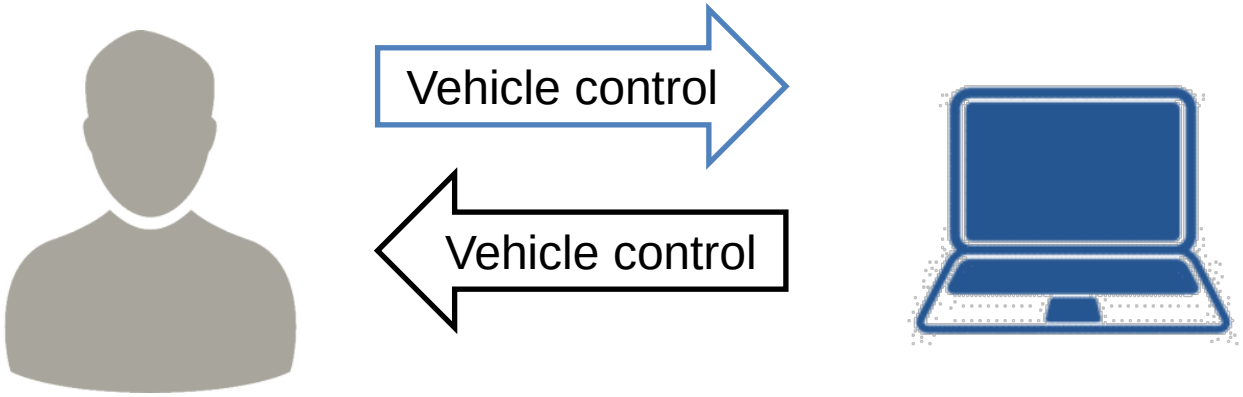


Problem description



Problem:

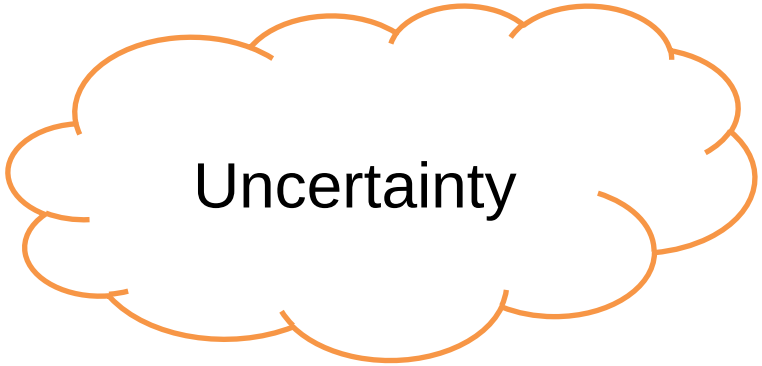
- Too frequent transitions lead to fewer acceptance of highly automated driving



Solution:

- In uncertain situations, bring the driver into a monitoring role (SAE level 2)

Problem description



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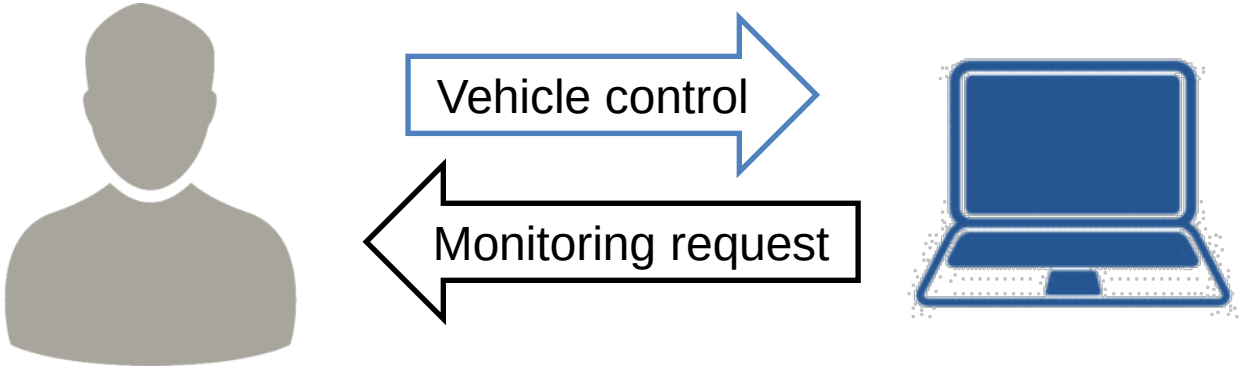


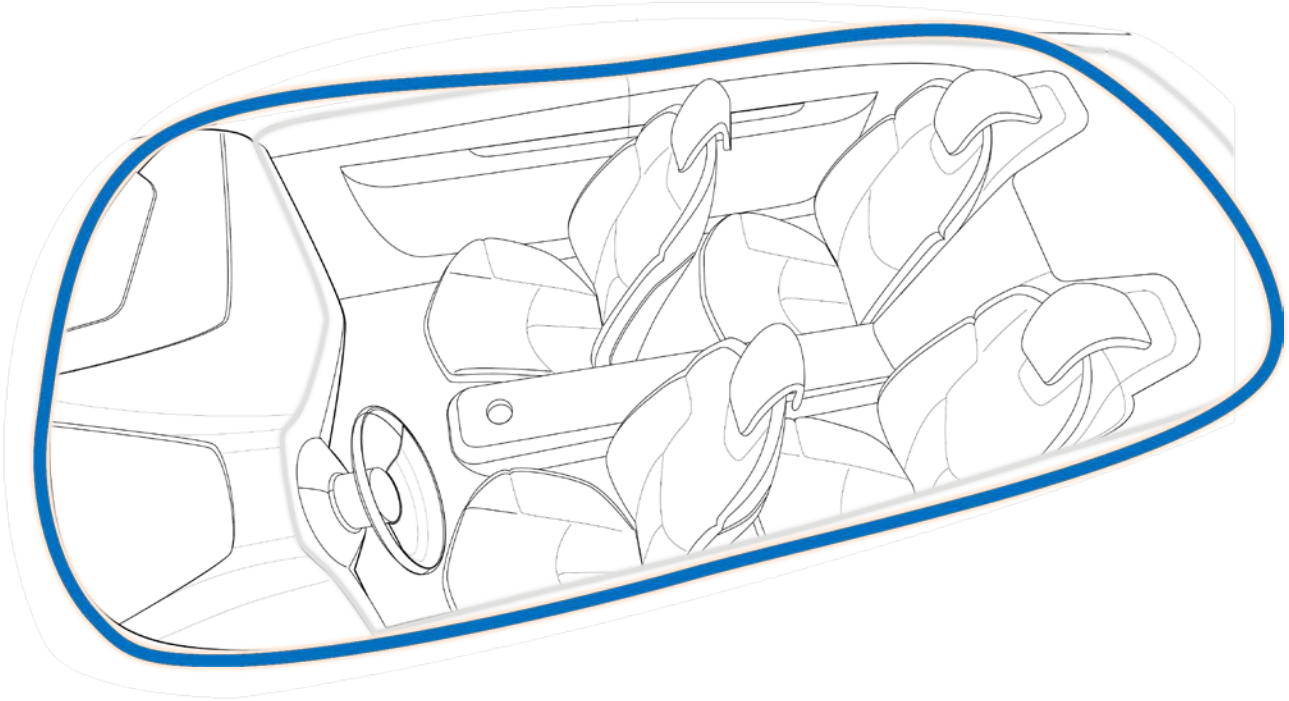
Solution:

- In uncertain situations, bring the driver into a monitoring role (SAE level 2)

Research Question

1. How can we bring the driver from level 3 into a monitoring role (SAE level 2)?
   → Ambient Light

- Information via peripheral vision
- Directed information about environment



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- Recommendations

Research Question

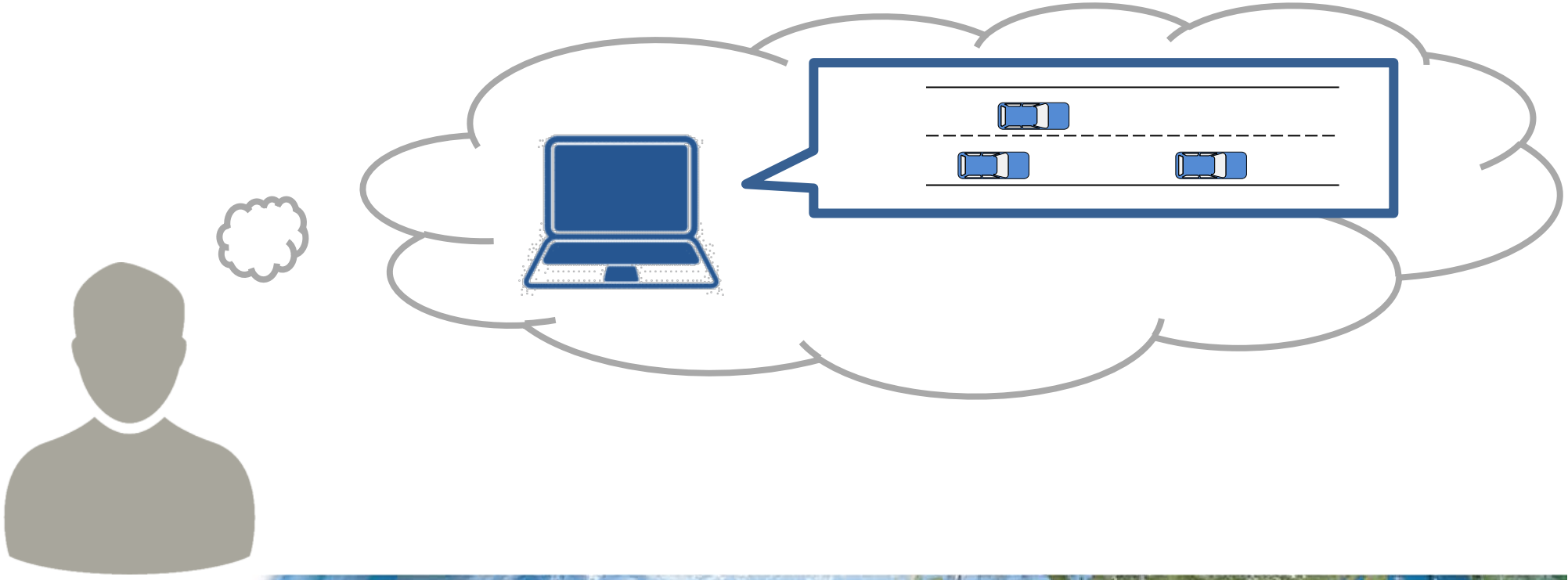
1. How can we bring the driver from level 3 into a monitoring role (SAE level 2)?
   → Ambient Light

- Information via peripheral vision
- Directed information about environment

- Warnings
- Recommendations
- Automation level

Research Question

2. Can specific information about tracked vehicles on the ambient light help the to anticipate critical situations?
   - Understand automation maneuvers?
   - Can automation failures be foreseen?



Dynamic driving simulator

40 Participants
20♀ 20♂

Experimental design

Between subject design

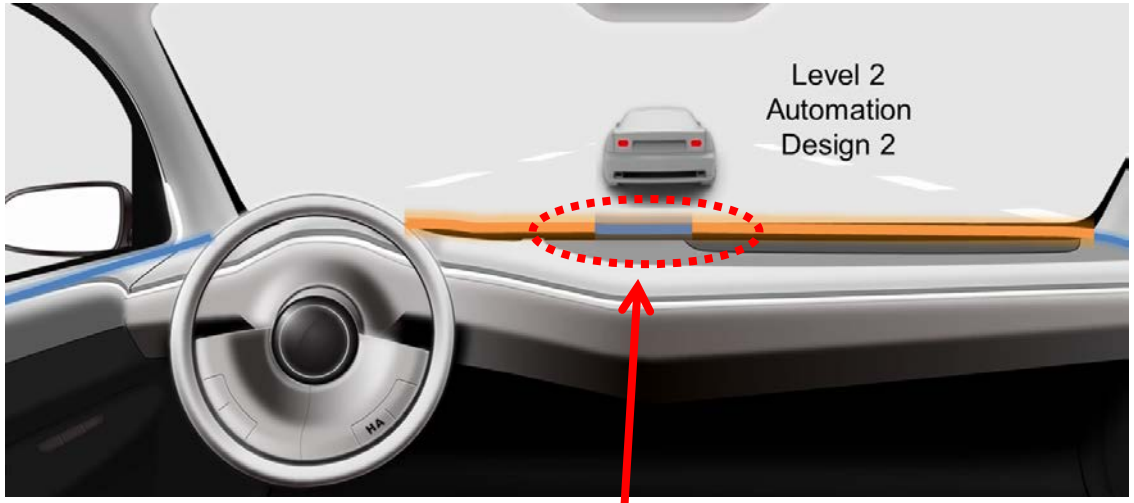
	Indication of tracked vehicle on LED	**No indication of tracked vehicle on LED**
Automation can handle situation	Indication	No indication
Automation can‘t handle situation (failure)	No indication	No indication

Uncertainty Feedback

Design for SAE Level 2

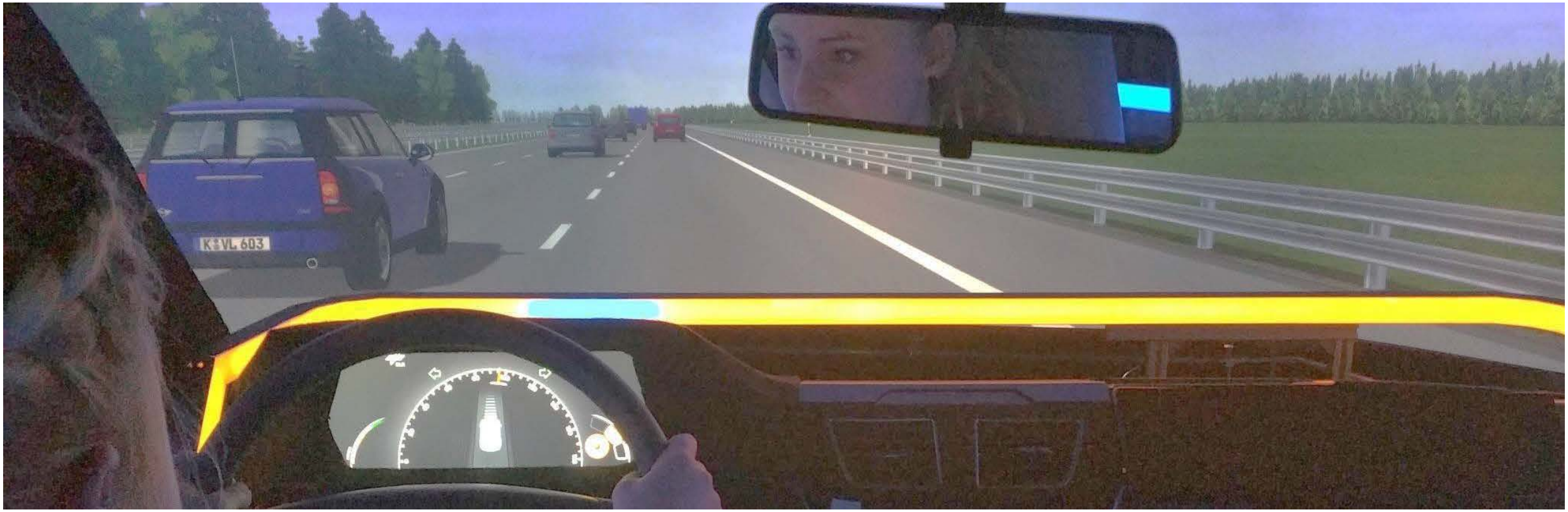
- Indication of detected vehicle
  - Ambient light with indication of detection vs.
  - Baseline with no further information

Design 1: Without indication



Design 2: With indication

Design for SAE Level 2



Scenarios

	Type I
Uncertainty Feedback	x
Indication of tracked vehicles	x
Automation reacts correct	√

SAE 3

Scenarios

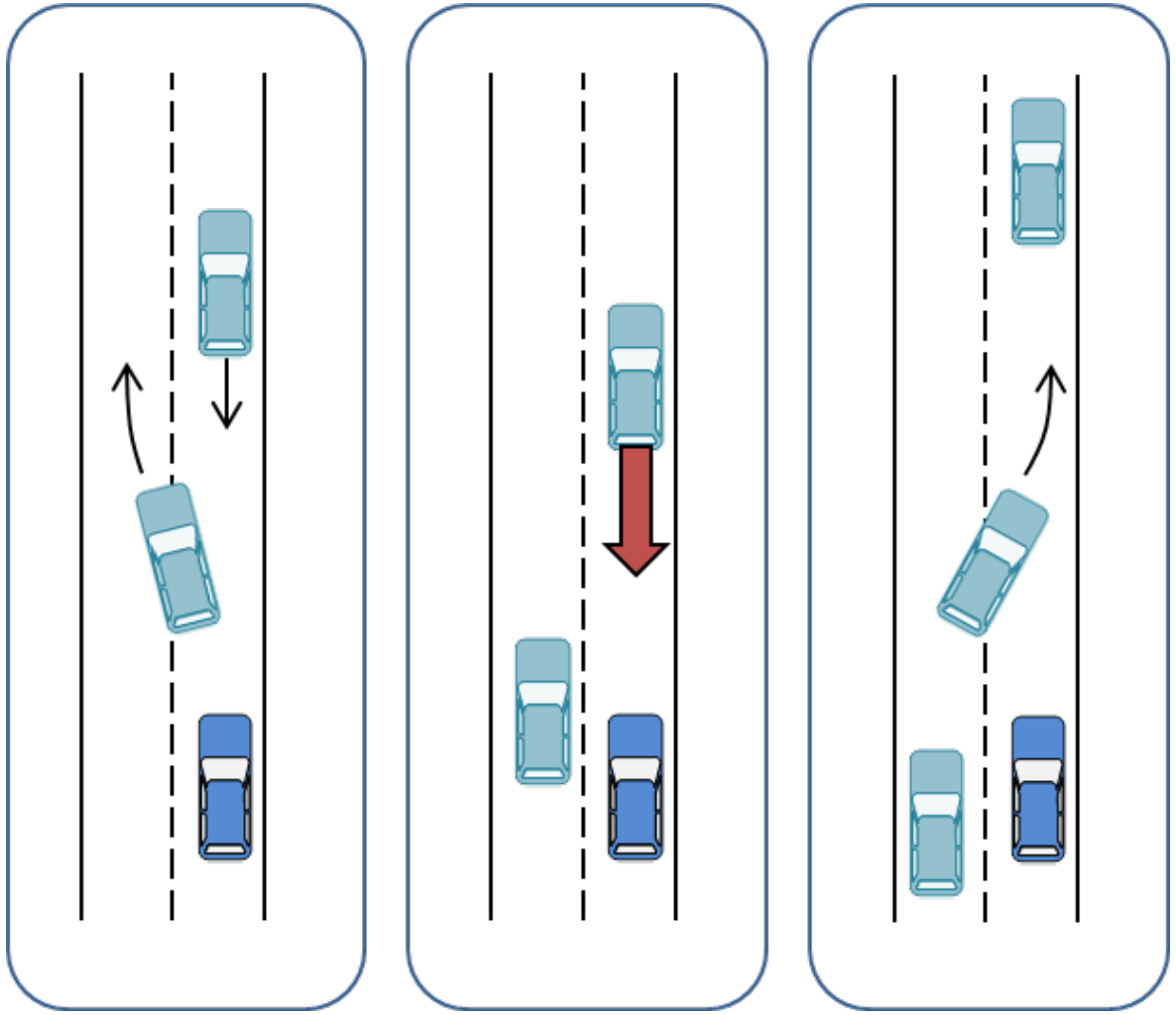
	Type I	Type II
Uncertainty Feedback	x	√
Indication of tracked vehicles	x	√
Automation reacts correct	√	√

Scenarios

	Type I	Type II	Type III
Uncertainty Feedback	x	√	√
Indication of tracked vehicles	x	√	x
Automation reacts correct	√	√	x

Scenarios

1. Uncertainty feedback
2. Situational change after 15 seconds



Data is not completely analyzed..

First results

Results

Question:

1. How can we bring the driver from level 3 into a monitoring role (SAE level 2)?

Answer:

- Gaze behavior changed after uncertainty Feedback (both designs)
  - Drivers focus the street significantly more $t_{(31)} = -4{,}017$, $p < 0{,}001$

Results

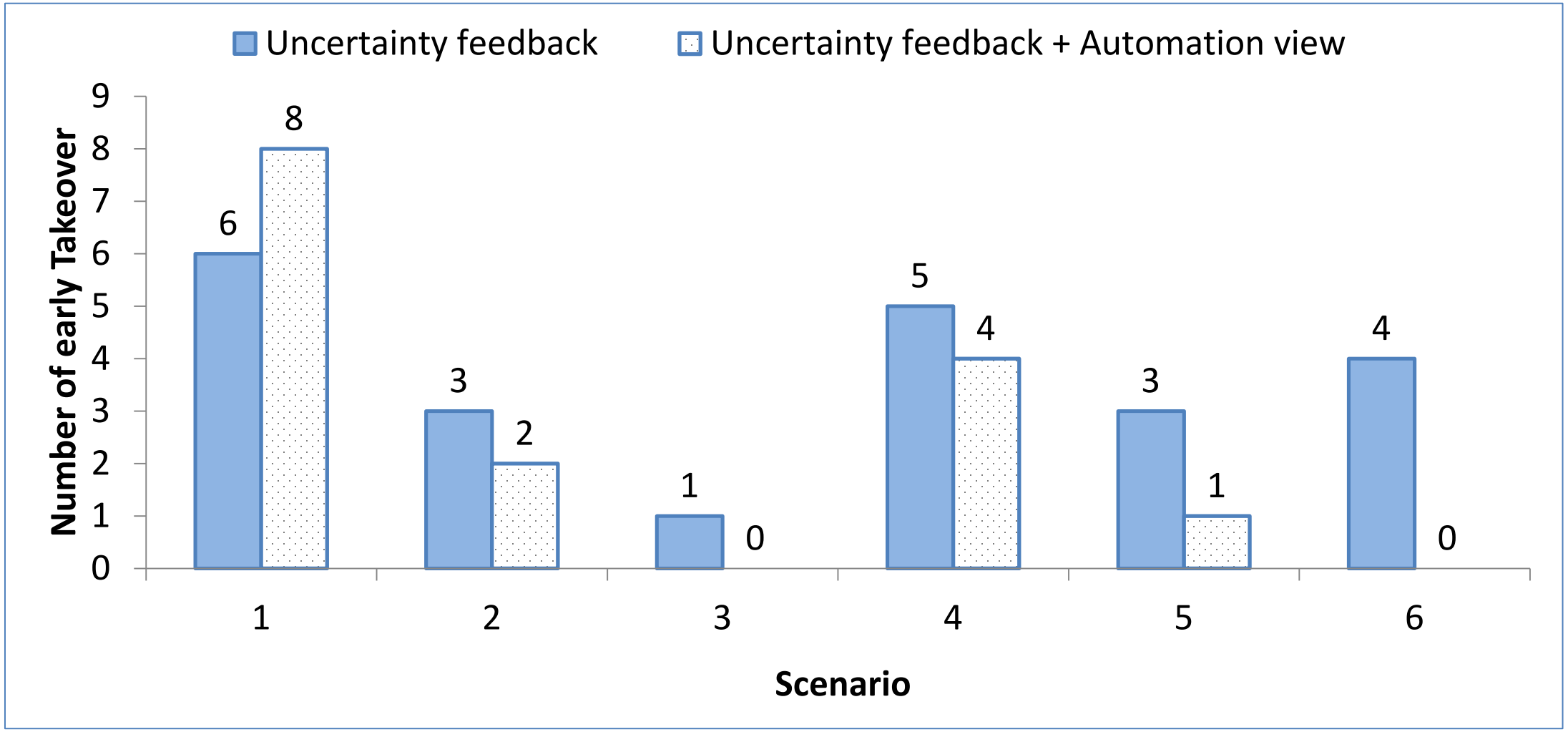
Question:

- Can specific information about tracked vehicles on the ambient light help the to anticipate critical situations?
  - Understand automation maneuvers?

Answer:

- No significant difference regarding early takeovers between the groups

Results


Uncertainty feedback
Uncertainty feedback + Automation view
Number of early Takeover
0
1
2
3
4
5
6
7
8
9
6
8
3
2
1
0
5
4
3
1
4
0
1
2
3
4
5
6
Scenario

Results

Question:

- Can the Ambient Light help drivers to anticipate automation behavior?
  - Can automation failures be foreseen?

Answer:

- Significant differences regarding distance to front vehicle at takeover
  $F_{(37)} = 3.94$, $p = 0{,}04$
  - Takeovers at a higher distance with indication of detected vehicles

Conclusion

- Ambient Display is effective in bringing drivers back into a monitoring role
  - Change in gaze behavior

- If feedback on detected vehicles via the Ambient Light helps to anticipate automation behaviour needs further exploration

Outlook

- Exploration of the ambient light in a test vehicle
  - Ongoing

- Exploration of ambient light for automated vehicles in urban scenarios

Thank you very much for your attention

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