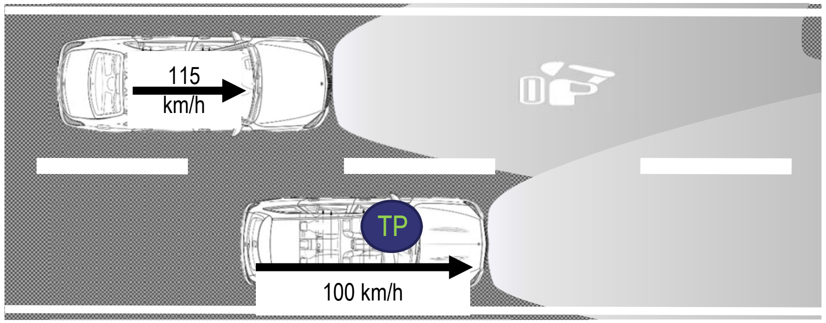
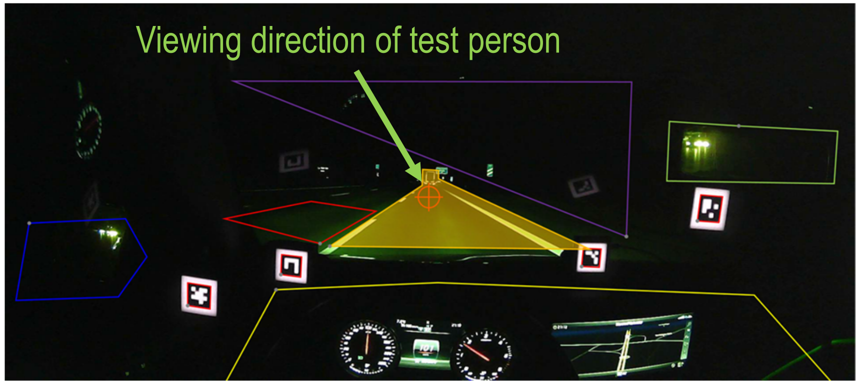
Study setup:
Distraction potential of road projection symbols



Test setup

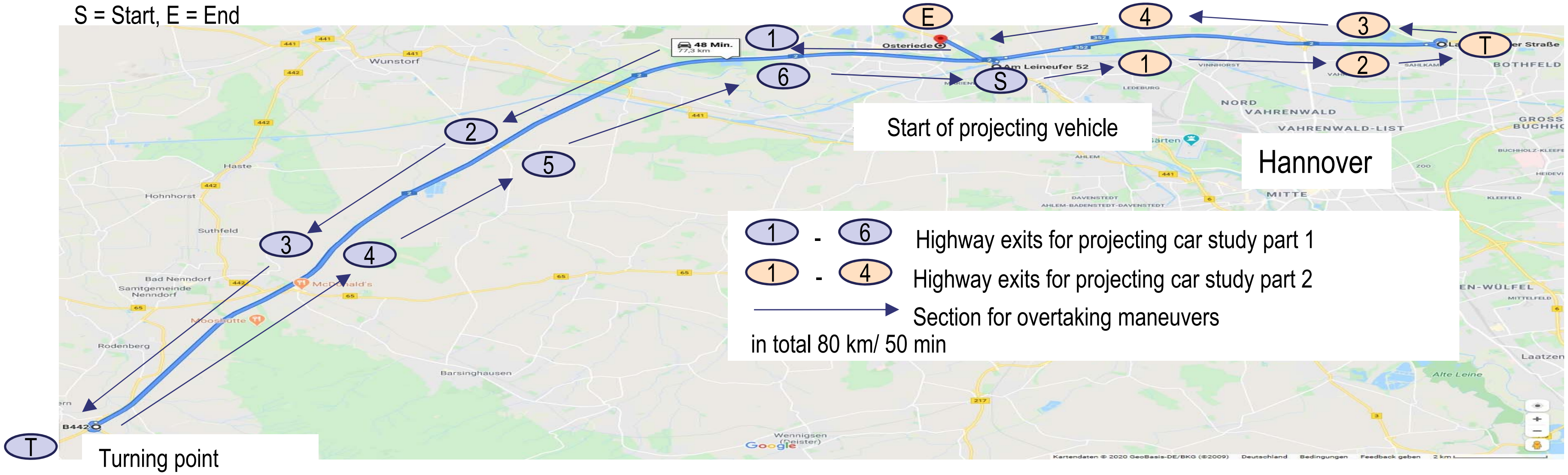


Eye marking map

- The test person (TP) is overtaken by the projecting vehicle while driving on the highway at dry conditions
- Nautical dusk as starting time (sun 6° below horizont; about 0,3 lux)
- Test person wears eye-mark glasses to measure glance direction and duration
- Speed difference: 15 km/h, overtaking maneuver of ~6s
- Symbol: excavator
- Static projection: Permanently on
- Dynamic projection: Continuous flashing 1 Hz with 0.5 s off

- First results from 26 test persons (15 male, 11 female); outlook for End of Oct 2020: 39 (24 male, 15 female)
- Age in years: 30.2 ± 11.3 (mean ± standard deviation); Min. 19; Max. 69

Study szenario and conclusions



Part 1

- Test persons are <u>not informed</u> about study objective
- Projected symbol is visible <u>in peripherical field of vision</u> of test person

Part 2

- Test Persons are <u>informed</u> about study objective and every overtaking maneuver
- Projected symbol is visible <u>in direct field of vision</u> of test person

→ Visual attraction of the investigated projections in real traffic situations is low
→ The study shows no indication of a decrease of road safety by static or blinking projections for other road users

→ The study indicates that when a test person is informed in advance, then a projection that is blinking becomes slightly more noticeable than one which projects statically.
→ Other road participants are able to see the projected light but are not able to recognize the projection as the right symbol

: Turning ideas into vision :

Progress on the main study:

Distraction potential of road projection symbols

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Motivation and aim of the study

Background:

- Modern vehicles communicate a large amount of information with the driver.
- Information is presented in the instrument cluster or with head-up displays.
- With head-up displays, the driver's gaze can stay on the road, but the information is not displayed in the direct field of vision. Therefore, eye movements are still required to correctly capture information.

Road projections as a new way of presenting information to the driver:

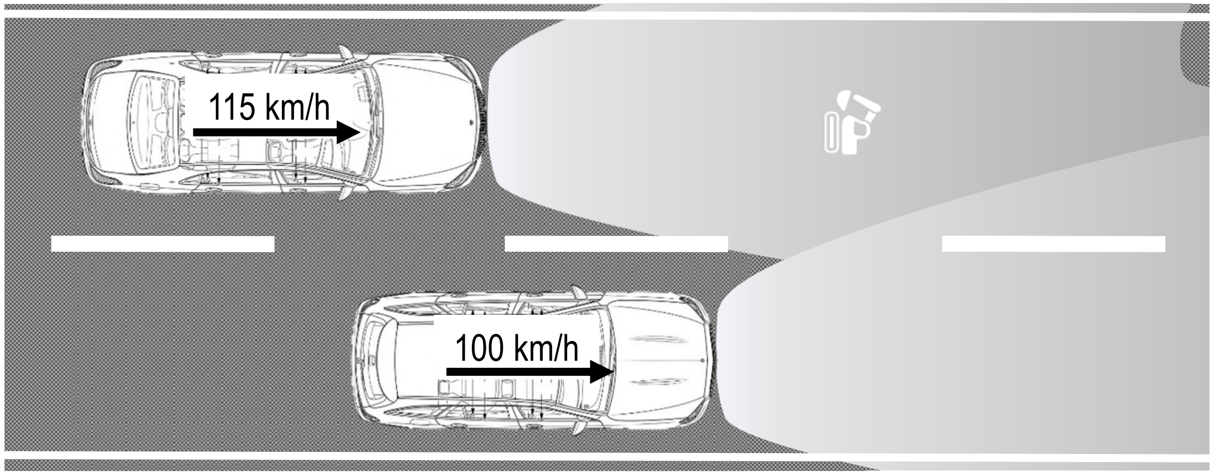
- Initial studies show the potential of road projections to increase road safety, especially for unsafe drivers [Hamm2018, Budanow2019]
- Projecting guidelines to enhance the centering of the car in the own lane has an influence to the drivers behavior [Rosenhahn2019]
- Investigations of the distraction potential are carried out due to the visibility for other road users. The studies are conducted on test tracks as well as in real traffic situations and the distraction is assessed using eye-tracking data. Recent studies show an increased number of glances at the projection, but not a critical distraction for static projections [Jahn2017, Polin2018]
- It is expected that blinking projections are more noticeable for the driver than static projections and are therefore preferred for road projections to inform and warn the driver.

Aim of this study:

- Investigation of the distraction potential of blinking symbols compared to static symbols
- Study on public roads in real traffic situations

Study setup

- The test person is overtaken by the projecting vehicle
- No special driving task, approx. 100 km/h, right lane on the motorway
- Speed difference: 15 km/h, overtaking maneuver of ~6s
- Symbol: Attention construction site / excavator
- Static projection: Permanently on
- Dynamic projection: Continuous flashing 1 Hz with 0.5 s off



- 26 test persons (15 male, 11 female), outlook: 39 (24 male, 15 female)
- Age in years: 30.2 ± 11.3 (mean ± standard deviation); Min. 19; Max. 69

- The test vehicle passing on left lane enables maximum possible attention to the projected symbol for the test persons, driving in a standard highway situation

Study Setup

iPeG

Study part 1:

- Test Persons are not informed
- Projected symbol is visible in peripherical field of vision
- Passing maneuvers are in randomized order
  - 2x without projection
  - 2x static projection
  - 2x blinking projection

Questions:
- Do the tests persons glance at the projection? → Eye-tracking data
- Do the tests persons see the projection consciously? → Questionnaire
- Is there a difference between static and blinking projection?

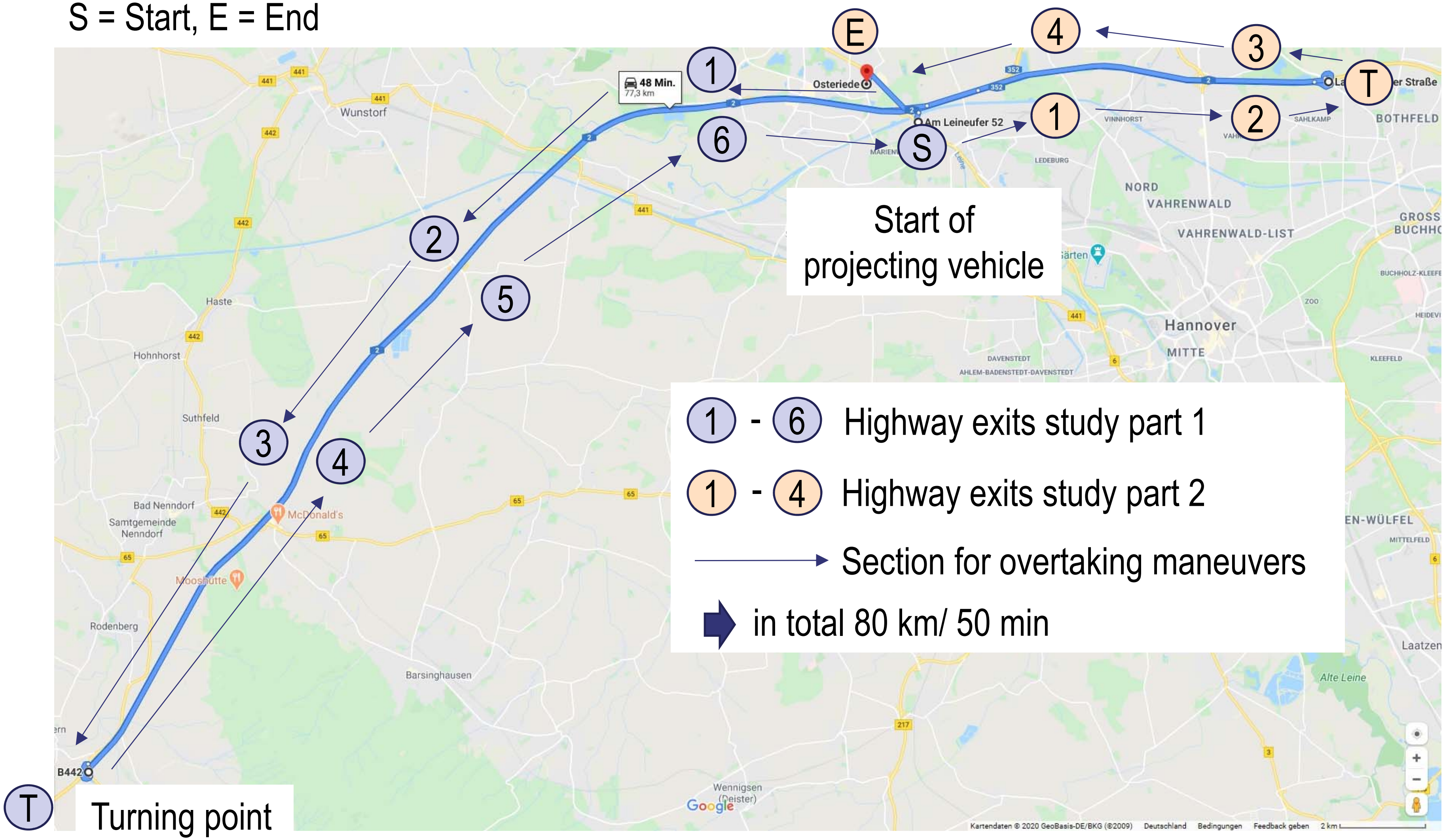
Study part 2:

- Test Persons are informed
- Projected symbol is visible in direct field of vision
- Passing maneuvers are in defined alternating sequence
  - 2x static projection
  - 2x blinking projection

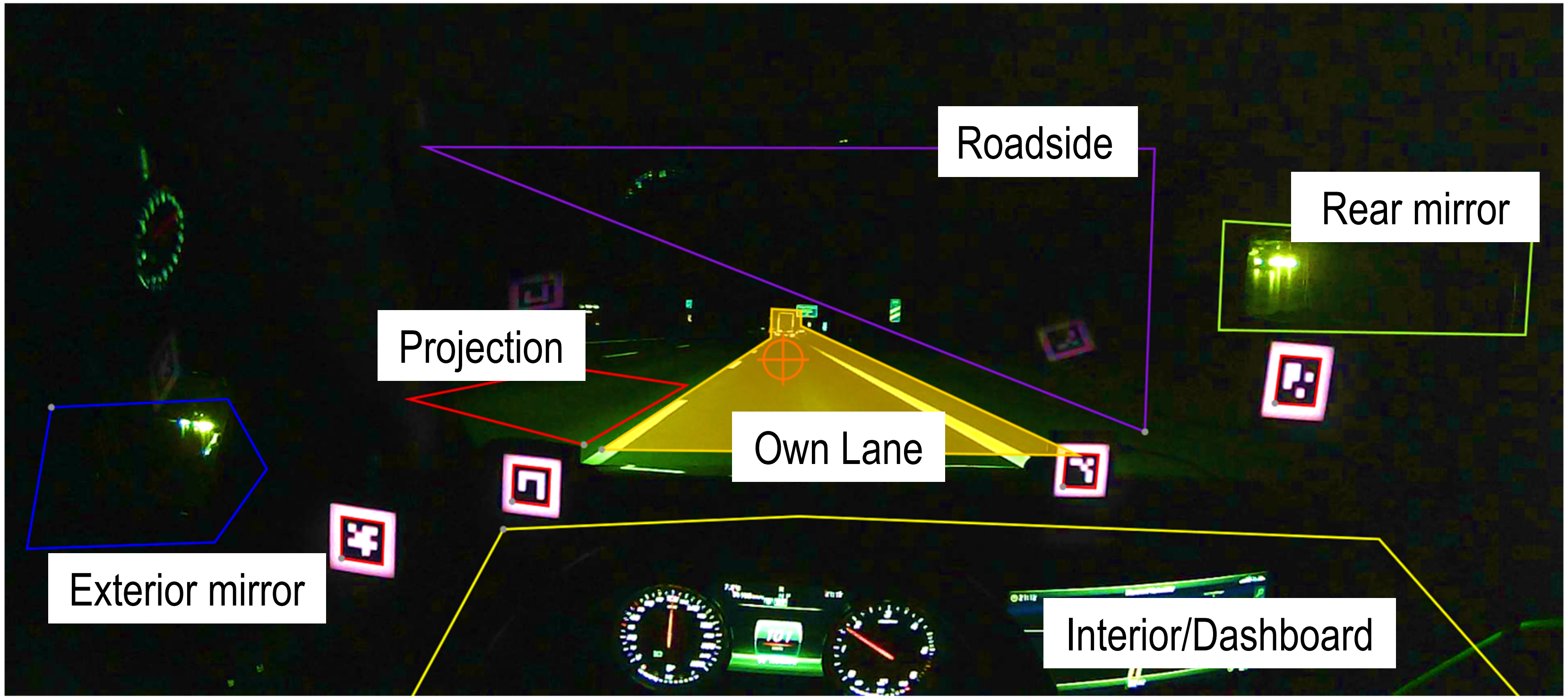
Questions:
- Do the tests persons glance at the projection? → Eye-tracking data
- Do the tests persons see the projection consciously and can they recognize the projected symbol? → Questionnaire
- How well is the projected symbol noticable for the tests persons? → Questionnaire

Route

S = Start, E = End



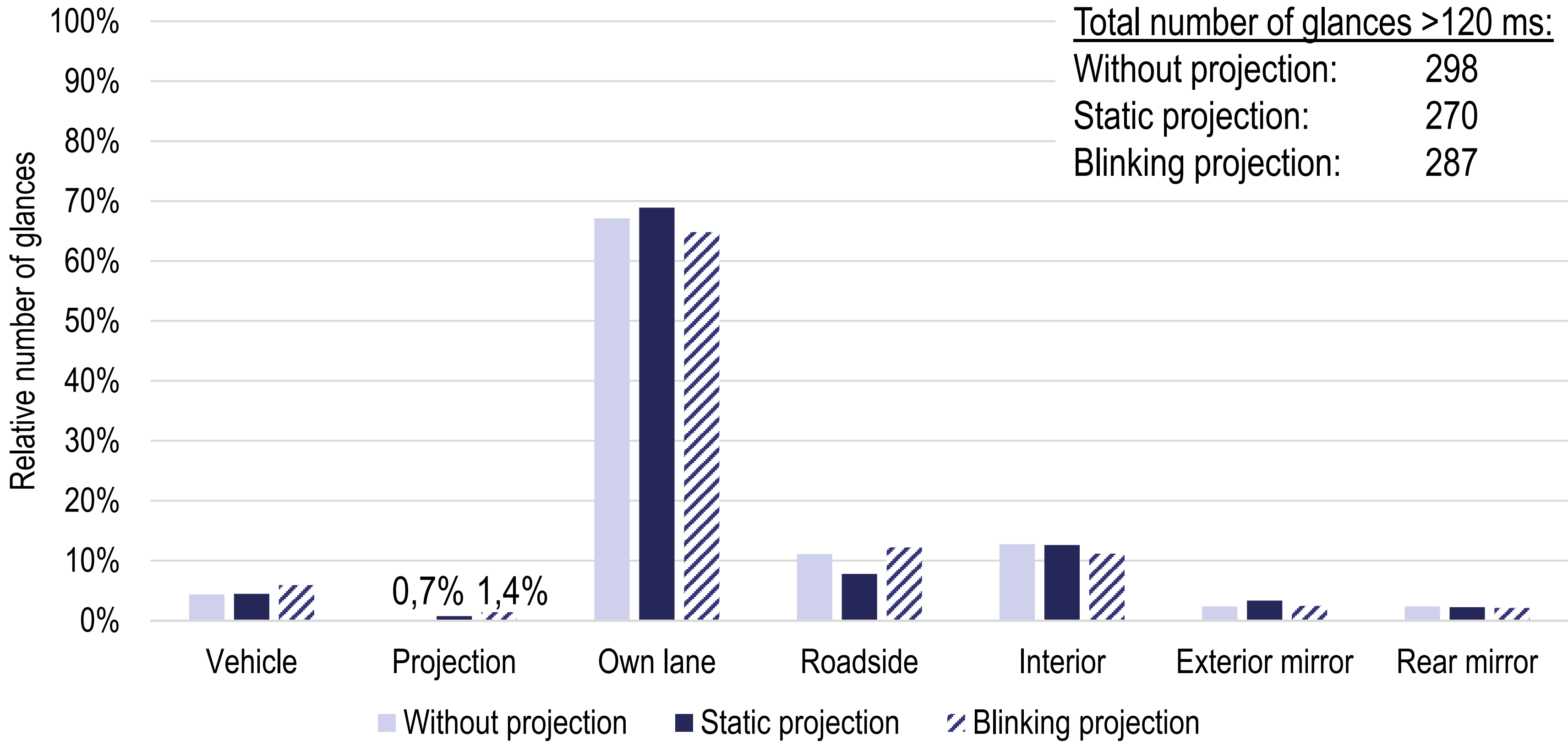
Evaluation of eye-tracking data



*Using Dikablis 3 Eye-tracking glasses

- Definitions of 6 areas in the field of view (stationary vehicle coordinate system)
- Automated calculation of the number and duration of glances at the areas during an overtaking maneuver
- Manual analysis of glances at the projection area in order to distinguish glances at overtaking vehicle from actual glances at projection

Study part 1: Relative number of glances during overtaking maneuvers

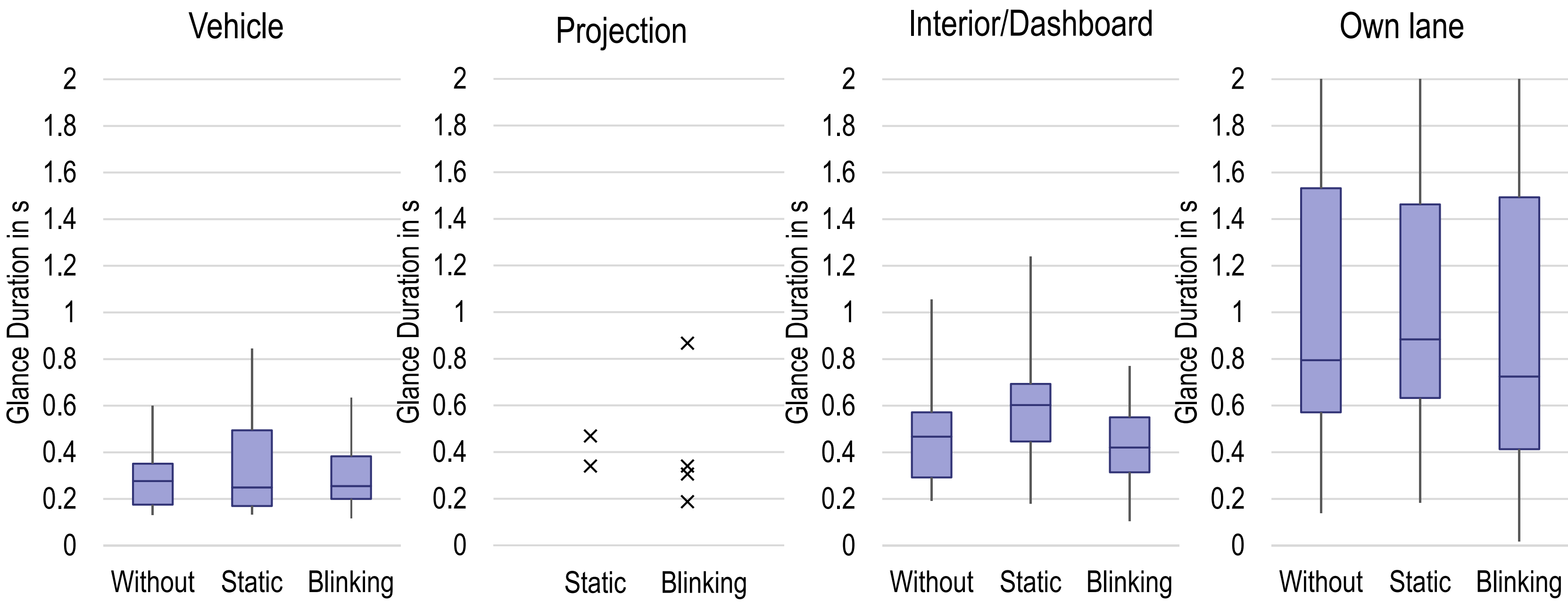


Total number of glances >120 ms:

Without projection:	298
Static projection:	270
Blinking projection:	287

- Overall glance distribution comparable to literature without projection [Serafin1993]
- Number of glances at the overtaking vehicle is in the range of that at the exterior or rear mirror
- Amount of glances at projections are very low; 2 glances at static projections and 4 glances at blinking projections

Study part 1: Glance duration during overtaking maneuvers



- Average and max glance duration at projection is comparable to the glance duration at overtaking vehicle, interior/dashboard (mean ~ 0,3 s), and exterior mirror (mean ~ 0,4 s)
- Glance duration at own lane is clearly longer than longest glance at projection
- Durations of all glances at projection are clearly below values for critical distraction from literature
  - 1,6 s [Horrey2007, Theeuwes2008]
  - 2,0 s [Zwahlen1988, Rockwell1998, Klauer2006]

Study part 1: Summary and conclusion

Do the tests persons glance at the projection?

- Based on the eye tracking data, 6 glances from 6 different test persons are directed at the projection on the road
- Glance durations at the projection are in the range of glance durations at the interior, overtaking vehicle and exterior mirror; Glance durations are clearly below values for critical distraction

Is there a difference between static and blinking projection?

- Eye-tracking data slightly indicates that the number of glances at blinking projections is higher than at static projections
- Average durations of glances at blinking and static projections are comparable

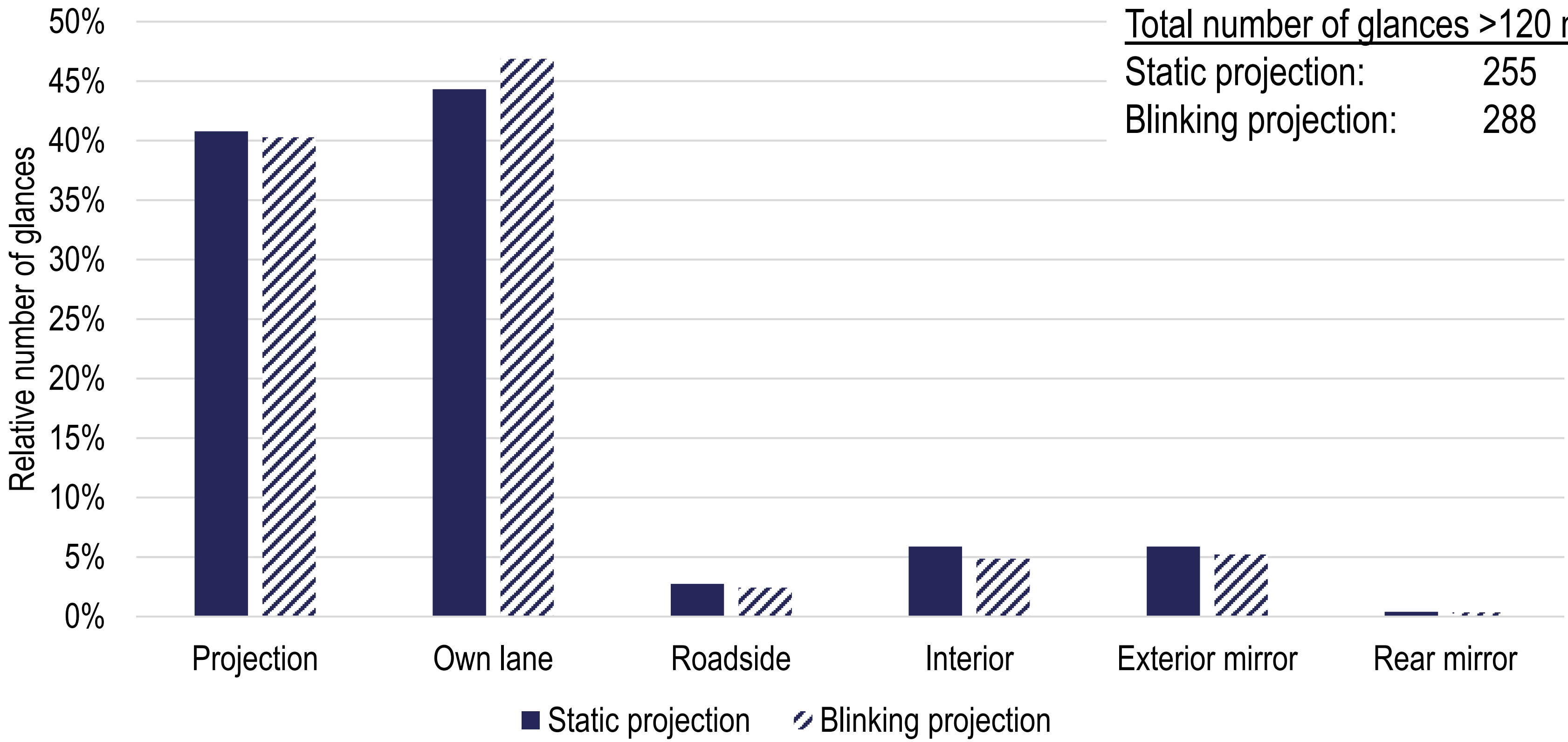
Do the tests persons see the projection consciously?

- Of 26 evaluated test persons, none stated that they had seen the projection in real traffic situation (Outlook on full study: one out of 39 tests persons could see the projection)

Conclusion of study part 1:

- Visual attraction of the investigated projections in real traffic situations is low
- The study shows no indication of a decrease of road safety by static or blinking projections
- For cleary different symbol contrasts and sizes further investigations are recommended

Study part 2: Relative number of glances during overtaking maneuvers

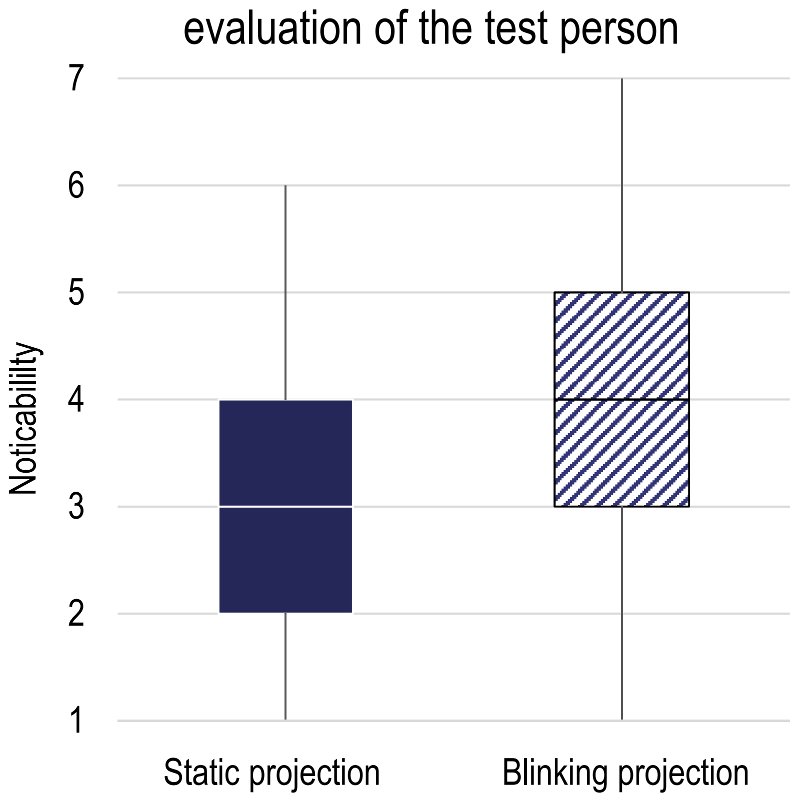


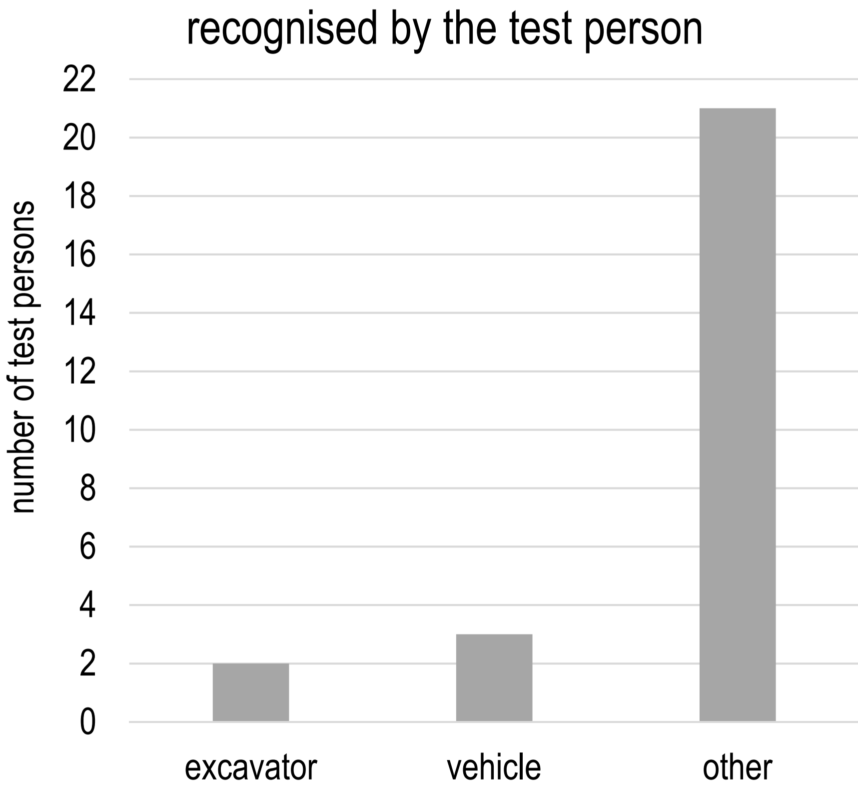
Total number of glances >120 ms:

Static projection:	255
Blinking projection:	288

- When looking at the projection consciously, the number of glances at the projection is about as high as the number of glances at own lane
- Glance duration at projection: Mean 1130 ms, Max. 6,85 s

Study part 2: Evaluation of noticability of projected symbols





- Blinking projections are rated on average (mean 3.35) about one scale step more noticable than static projections (mean 4.25) when the test person is informed in advance
- Correct symbol could only be perceived in individual cases, which are hardly significant compared to the false answers. This may be due to the different perspective of the test subjects and the associated lower contrast of the projections.

Study part 2: Summary and conclusion

Do the tests persons glance at the projection?

- Analysis of eye-tracking data shows that all tests persons glanced at the projection
- Number of glances is about as high as number of glances at own lane

Do the tests persons see the projection consciously and can they recognize the projected symbol?

- All tests persons stated that they could percieve the projection
- Two test persons stated that they recognized an excavator

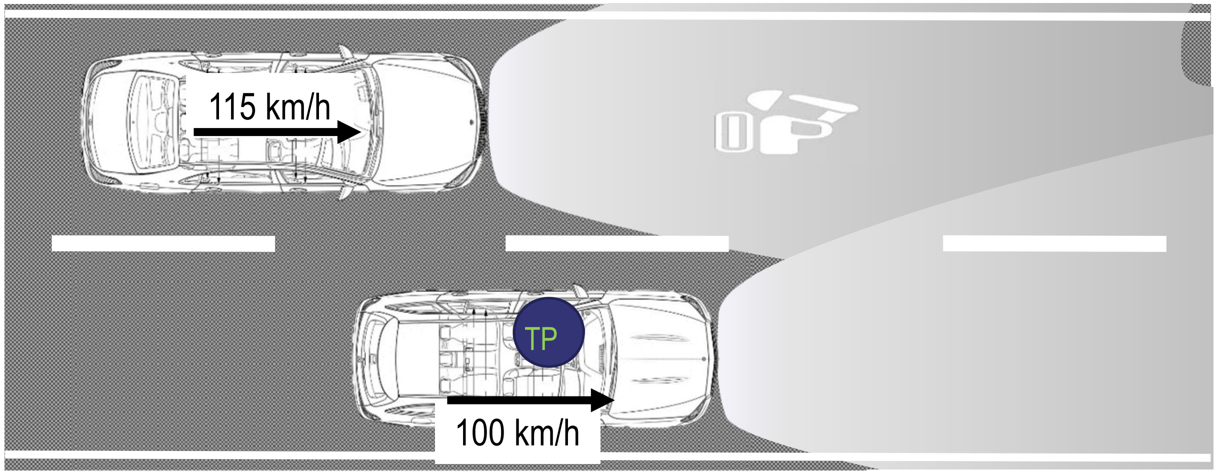
How well is the projected symbol noticable for the tests persons?

- Blinking projections are rated on average about one scale step more noticable than static projections when a test person is informed in advance

Conclusion of study part 2:

- Projected light is visible for other road participants
- Practically no information transfer to other road participants due to poor recognition of the correct symbol
- The study indicates that blinking projections are slightly more noticable than static projections when the test person is informed in advance

Study Conclusions



Part 1

- Test Persons are not informed about study
- Projected symbol is visible in peripherical field of vision

→ Visual attraction of the investigated projections in real traffic situations is low
→ The study shows no indication of a decrease of road safety by static or blinking projections
→ For different symbol contrasts and sizes further investigations are recommended

Part 2

- Test Persons are informed about study objective and every overtaking maneuver
- Projected symbol is visible in direct field of vision

→ The study indicates that when a test person is informed in advance, then a projection that is blinking becomes slightly more noticeable than one which projects statically.
→ Other road participants are able to see the projected light but are not able to recognize the projection as the corresponding symbol

Literature

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