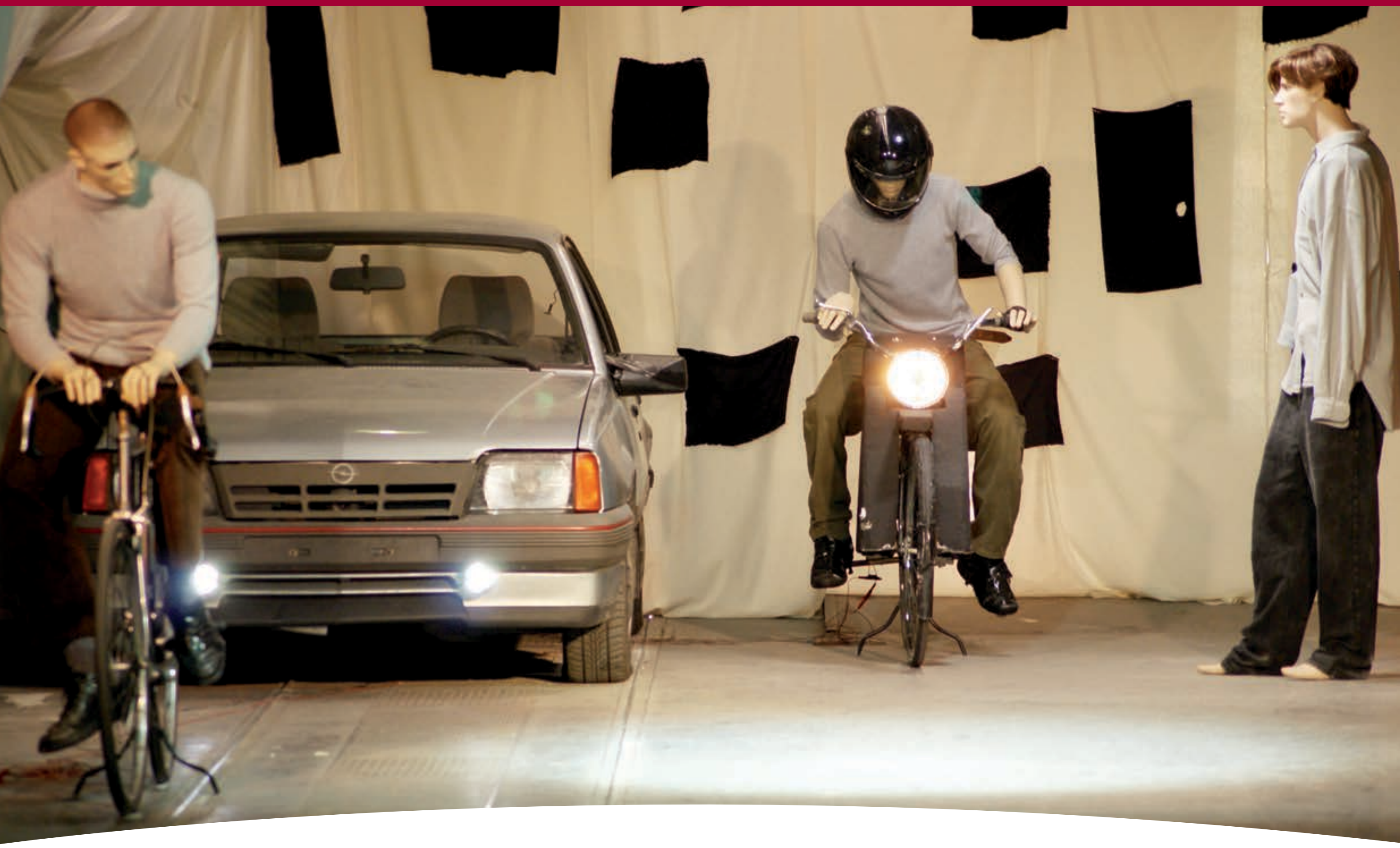
German Insurance Association No. 24



Compact accident research

Daytime Running Lights for cars - analysis of the effect on traffic safety

Unfallforschung der Versicherer
GDV

Imprint

German Insurance Association
German Insurers Accident Research

Wilhelmstraße 43/43G, 10117 Berlin
PO Box 08 02 64, 10002 Berlin
unfallforschung@gdv.de
www.udv.de

Editor: Dr. Matthias Kühn
Layout: Franziska Gerson Pereira
Photo references: Insureres Accident Reseach

Published: 04/2011

Introduction

The European Commission has decided that new types of passenger cars have to be equipped with dedicated Daytime Running Lights (DRL) from 07.02.2011 on. DRL are considered as a long-lasting and energy-saving alternative to low beam headlights and are supposed to increase traffic safety. Studies indicate a considerable decrease in accident numbers. Estimations on a conservative basis average out at 3 to 4 % [1, 2]. Its opponents however fear for the safety of vulnerable road users.

Content

1 Project Goal

On behalf of German Insurers Accident Research (UDV) Human-Factors-Consult GmbH examined safety effects and risks of DRL in cooperation with the department of Lighting Technology of the Technical University of Berlin. The following research questions were addressed:

- Evidence of safety effects and risks: Which effects do DRL have for car drivers and vulnerable road users?
- Comparison of selected accident types: Do they show different DRL-related effects?
- Assessment of the sustainability of effects: Do they even out over time due to habituation?
- Control of demographic and situational characteristics: Do they moderate the effects of DRL?
- Comparison of low beam headlights as DRL and dedicated DRL: What difference does it make?

Within the 2.5-year project period three empirical studies were carried out:

(1) Driving study including gaze measurement in Germany and Denmark
(2) Laboratory study in the light tunnel of the Technical University of Berlin
(3) Driving Simulator study assessing gaze and driving behaviour.

By choosing different methodical approaches it was possible to analyse various aspects in detail, and to mutually validate the results. It also combined experimental control with evidence of the transferability of results in real traffic.

2 Literature Review

At the beginning of the project reviewed literature was classified by selected criteria and assessed regarding methodical quality and explanatory value. It was thereby possible to identify credibly substantiated effects from statements that lack significance. Most of the studies are based on accident statistics for car models equipped with or without DRL (low beam) or on national accident statistics. They compare accident numbers before and after the use of running lights at daytime has become mandatory. Their reported decreases in accident numbers often reach double digits and are mostly not statistically significant, i.e. they are due to random deviations. These are often misinterpreted as safety effects, which eventually leads to predictions of accident decreases up to 25 % [3], even though neither safety effects nor risks are sufficiently substantiated. Accident studies fail to separate the effect of DRL from confounding factors (e. g. fleet studies and national studies) or lack sufficient number of cases (experimental design) to conduct a well-founded statistical analysis. Studies conducted in the laboratory prove a significantly improved perceptibility for cars with running lights at daytime, while a disadvantage for vulnerable road users has not been verified so far. For methodical reasons the transferability of these results in real traffic cannot be assumed. A driving study [4] interprets slightly longer gaze durations for cars with lights switched on as a DRL-induced gaze capture and hence assumes negative effects for vulnerable road users. The sometimes pronounced position pro vs. contra DRL is surprising, the more so as neither advantages and risks of DRL nor their mode of action (attention allocation, gaze capture) have been convincingly supported.

3 Driving Study

In the first part of the driving study the gaze behaviour of car drivers towards cars with and without DRL (low beam) and towards vulnerable road users was analyzed. The study focused on intersections in built-up areas to compare effects for selected accident types (turn off and turning/crossing). In the second part the influence of DRL (low beam) on the detection of powered two-wheelers was examined.

Part 1: Analysis of gaze behaviour

The subjects were told to follow a given route in Germany and Denmark. The gaze behaviour of 50 subjects towards cars with vs. without lights switched on and towards powered two-wheelers, bicyclists and pedestrians was assessed. Situational characteristics and demographical factors were also recorded and analysed. The results are based on the gaze directions towards 2500 road users.

Questions

- Do gaze directions differ for cars with vs. without DRL (low beam)?
- Do DRL (low beam) influence gaze behaviour towards vulnerable road users?
- Do effects differ for the selected accident types?
- In which way do situational factors, e.g. surrounding luminance, influence the results?
- Can habituation effects be verified by comparing the German and Danish sample?

Results

The gaze behaviour of car drivers shows only minor effects for DRL (low beam). Different gaze measures (first, average and cumulative gaze duration and number of gazes) do not yield significant results in sunny conditions. In clouded and rainy conditions the cumulative gaze duration is 0.24 s longer for cars with DRL (low beam). This implies an increase in conspicuity. However, practical implications regarding traffic safety are negligible. There are no significant effects for vulnerable road users. The gaze behaviour of Germans and Danish differs, but there is no indication for a habituation effect. For lack of case numbers a statistical comparison of the selected accident types was not possible. Alternatively, the direction from which cars approach the junction was analyzed. A moderation effect could not be verified.

Figure 1: Experimental vehicle (left) and test person with gaze measurement device (right)

Part 2: Detection of powered two-wheelers

In the second part of the driving study subjects were told to report any powered two-wheeler they notice in traffic without systematically searching for them.

Questions

- Are powered two-wheelers overlooked more often in situations with cars using DRL (low beam)?
- Do situational characteristics, e.g. surrounding luminance, moderate the results?

Results

The comparison of perceived and overlooked powered two-wheelers does not show a significant effect of DRL (low beam). Even though some situational, person- and object-related features improve or impair the detection of powered two-wheelers in general none of them leads to a significant interaction with DRL (low beam).

4 Laboratory Study

A simple traffic scene was presented to the subjects for a very short time (120 ms) while a continuous tracking task had to be executed simultaneously. Subjects had to decide if another road user was present or not, and identify him afterwards. The surrounding luminance was varied to represent daylight and twilight conditions. Part of the scenery was a car with either no lights, halogen low beam headlight or LED DRL and either

- No other road user
- Bicyclist (in front of car)
- Pedestrian (next to car)
- Motorcyclist (in front of vs. next to car).

Questions

- Do DRL or low beam headlights influence the detection rate, i.e. the perception and identification of vulnerable road users?
- Do DRL or low beam headlights influence the reaction time, i.e. the period of time between scene presentation and perception?
- Are there effects on the certainty of judgment?

Results

The detection performance is not influenced by DRL or low beam. Vulnerable road users are not overlooked more often in any condi-

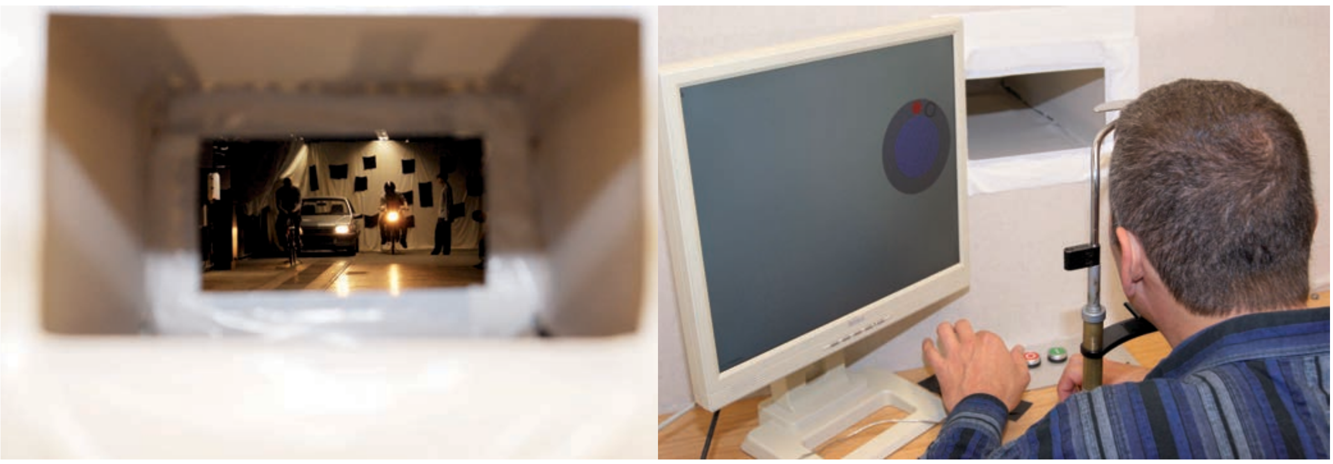


Figure 2: Test persons's view at the scene (left) and positioning of test person with tracking task (right)

tion. In the scene with 'motorcyclist next to car' reaction time shows an increase of 0.2 s for DRL and low beam. The certainty of judgement also declined. However, the comparatively longer reaction times now match observed longer reaction times for all the other road users. So there is no sufficient evidence of risks for vulnerable road users involved by use of DRL (low beam).

5 Driving Simulator Study

The tests took place in the driving simulator environment of the professorship for traffic and transportation psychology at the Dresden University of Technology. 20 subjects followed a given route in a simulator environment. The driving behaviour (gap acceptance) at junctions in built-up areas and gaze behaviour towards powered two-wheelers, bicyclists, pedestrians and cars with vs. without lights switched on were analysed. The data base comprises driving behaviour at more than 400 junctions and gaze behaviour towards 1300 road users.

Questions

- Do DRL (low beam) influence gaze behaviour towards cars and vulnerable road users?
- Do DRL (low beam) lead to an earlier attention allocation for cars or a late attention allocation for motorcyclists, bicyclists and pedestrians?
- Does a differentiation of accident types lead to different results for DRL (low beam)?
- Do DRL (low beam) influence gap choice and distance left to approaching vehicles?

Results

There is no significant effect of DRL (low beam) on gaze behaviour. Gaze directions do not occur sooner, longer or more often for cars with lights switched on, nor later, shorter or more rarely for vulnerable road users. Both gap acceptance and the distance left to approaching vehicles are not influenced by DRL (low beam). Even in scenarios with a motorcyclist being followed by a car with lights switched on (the assumed worst case scenario of DRL associated risks) no risks could be observed. Different accident types show no significant effects in gaze and driving behaviour which can be traced back to DRL (low beam).

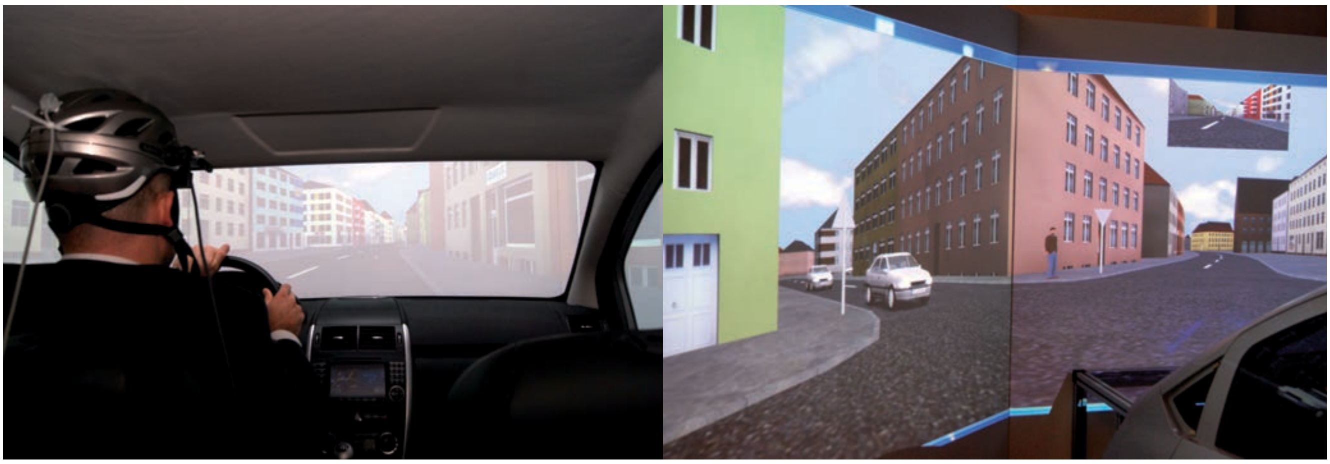


Figure 3: Driving Simulator environment with Subject and gaze measurement device (left) and a typical built-up scene (right)

6 Conclusion

There are only minor effects for DRL (low beam). Cars with lights switched on show an increase of 0.24 s in the cumulative gaze duration in clouded and rainy weather. This is due to single gaze directions occurring more often without changing in their average duration. That is why, this implies no traffic safety risk. Gaze directions do not occur sooner for cars with lights switched on nor later for vulnerable road users. An influence of DRL (low beam) on driving behaviour could also not be observed. Gaze behaviour of car drivers towards bicyclists and pedestrians does not differ when cars use DRL (low beam), nor are powered two-wheelers overlooked more often. The laboratory results point out a single significant prolonged reaction time of 0.2 s when a motorcyclist is presented next to a car. However, this does not indicate a safety risk. It represents a methodical artefact due to the static setting and will therefore not have any effects in real traffic. The effect of many factors (e.g. habituation, differentiation of accident types) cannot be concludingly evaluated, because the overall effect of DRL (low beam) was rather small. Even so, the empirical data base is particularly with regard to the field study remarkably extensive. Even minor effects of DRL (low beam) could have been proven, if they existed. Based on the conducted research it can be concluded that DRL (low beam) lead to no positive effects with respect to traffic safety, that risks were not observable, and that a noticeable effect of DRL (low beam) on accident numbers cannot be expected.

More information under:
www.udv.de
www.youtube.com/unfallforschung

Literature

[1] Schönebeck, S., Ellmers, U., Gail, J., Krautscheid, R. & Tews, R. (2005). Abschätzung möglicher Auswirkungen von Fahren mit Licht am Tag (Tagfahrleuchten / Abblendlicht) in Deutschland, The Federal Highway Research Institute (BASt).

[2] Elvik, R., Christensen, P. & Olsen, S. F. (2003). Daytime running lights: A systematic review of effects on road safety, Transportøkonomisk institutt. IR 2.

[3] Koornstra, M., Bijleveld, F. & Hagenzieker, M. (1997). The Safety Effects of Daytime Running Lights: A perspective on Daytime Running Lights (DRL) in the EU: the statistical reanalysis and a meta-analysis of 24 independent DRL evaluations as well as an investigation of possible policies on a DRL regulation in the EU, SWOV Institute for Road Safety Research.

[4] Pfleger, E. (2007). Untersuchung von blicktechnischen Interaktionen im realen Straßenverkehr in Ortsgebieten und Freiland: Blickanalysen mit dem Viewpointsystem unter Einsatz modernster High-Tech-Rasteranalyseprogramme zur wissenschaftlichen Bewertung der Auswirkungen von Licht am Tag (Positionspapier Erstinformation), EPIGUS - Institut für ganzheitliche Unfall- und Sicherheitsforschung.

German Insurance Association

Wilhelmstraße 43/43G, 10117 Berlin
PO Box 08 02 64, 10002 Berlin

Phone: + 49 30/20 20 - 50 00, Fax: + 49 30/20 20 - 60 00
www.gdv.de, www.udv.de