Effects of Rear Lights on Cars by Daylight

Björn Lidestam[1](✉), Hanna Hugosson[1,2], Ilona Kröll[1,2], and Kajsa Weibull[1]

[1] VTI, The Swedish National Road and Transport Research Institute, 581 95 Linköping, Sweden
bjorn.lidestam@vti.se
[2] Linköping University, 581 83 Linköping, Sweden

Abstract. Effects of rear-light usage by daylight were examined. A field experiment measured passing vehicles' lateral distance to a stationary car, as an effect of rear-light status. A questionnaire survey measured car drivers' perceptions regarding safety and visibility depending on rear-light usage, and their experiences, preferences, and beliefs about own usage of rear lights in daylight. An observational study measured percentages of cars with lit and unlit rear lights, respectively, in sunshine during summer. Results show that rear lights give greater lateral distance when being passed by. A car with lit rear lights is interpreted as more likely to start driving. Lit rear lights are preferred and estimated to give better visibility and traffic safety. Only a small proportion of drivers know that they drive with unlit rear lights in daylight, whilst the majority actually drive with unlit rear lights. Conclusion: lit rear lights in daylight improves traffic safety. It is therefore recommended that rear lights with sufficient brightness to be seen even in sunshine should be legally required.

Keywords: Rear light · taillight · tail light · vehicle lighting · daytime running lights · traffic safety · visibility · detectability · road user behaviour · driver behaviour

1 Introduction

This study investigated the effects of car rear lights by daylight, dawn and dusk – in light conditions when cars should be clearly visible even without lit headlights and rear lights. In daylight, lit rear lights should not contribute much and significantly to whether cars are detected, or how early or at what distance they are detected. However, it is conceivable that if a car does not have its rear lights visibly lit, it may be more difficult for other drivers to identify if it is running, and if it can therefore make a sudden change in position. A car with lit rear lights is reasonably more likely to have a person in the driver's seat, and its engine should be more likely to be running. To avoid collisions, it can be time-critical to detect vehicles in traffic, where they are, in which direction they are traveling, and what their drivers intend to do. A vehicle must have the lights and headlights that are prescribed for the vehicle lit, however, if prescribed warning lights are used on a car in daylight, the rear or side lights do not need to be lit [1].

© The Author(s) 2026
C. McNally et al. (Eds.): TRAconference 2024, LNMOB, pp. 69–75, 2026.
https://doi.org/10.1007/978-3-031-88974-5_11

In 2011, the European Union introduced requirements for automatic daytime running lights at the front of all new cars, but in order to reduce carbon dioxide emissions, this did not apply to the rear lights [2]. A requirement was introduced in August 2016 that new passenger cars and trucks must also have automatic rear lights, at minimum when the ambient brightness falls below 1000 lx, for example in darkness or when driving in tunnels [2, 3].

It has been claimed that rear lights can be unlit without impairing road safety and that unlit rear lights are a way to save energy and for the car industry to work towards more sustainable driving (e.g., [4]), and that there are no studies that indicate that unlit rear lights during the day would reduce road safety and that lit rear lights rather impedes the visibility of the brake lights (e.g., [3], citing [5]). However, [5] is both 20 years old and lacks reference to such empirical evidence. Rear lights on cars also vary widely in brightness, and many newer versions are dimly lit. When the sun shines on a newer car, it can therefore be very difficult to see if its rear lights are lit. At the same time, it is quite clearly visible if the same car's headlights are on, because the headlights shine significantly brighter. Previous Swedish large-scale observational surveys showed that 15% of vehicles had unlit rear lights in the dark in 2018, and that 5% had unlit rear lights in the dark while 21% had unlit rear lights in daylight in 2021 [6, 7].

The overall aim was to investigate the effects of rear-light status (i.e., whether the rear lights are lit or unlit) on driver behavior in surrounding traffic; and drivers' attitudes and experiences of visibility and road safety as an effect of rear-light status. In addition, the agreement between Swedish drivers' awareness of whether they have their rear lights lit or unlit in daylight, and the actual use of rear lights in daylight was also investigated. The study was conducted as a field experiment, a questionnaire survey, and an observational study.

2 Field Experiment

The *purpose* was to investigate whether a stationary vehicle's rear-light status (lit/unlit) affects how much lateral distance passing vehicles keep. A further aim was to investigate what percentage of Swedish passenger cars have unlit rear lights at sunrise, sunset and during the day.

Method. Data was collected on five different occasions in April 2023 on a country road with single lanes in both directions. The speed limit is 70 km/h, lane width 3.5 m, dashed center line (3 m long, 9 m interval), and dashed edge line (1 m long, 1.5 m interval). Two occasions were at dawn, two at dusk, and one was a gray overcast morning. A grey Toyota Avensis station wagon, 2010 model, rear lights with bulbs, filament, was parked in the road clearing, 1 dm to the right of the dashed border. Inside were three cameras, two of which were directed backwards, and one forward. The rear lights were lit and unlit approximately every four minutes, whenever possible when no vehicle was approaching and could see the lights being switched on or off. $N = 850$ passing vehicles were videotaped, $n = 765$ related to their own rear-light status (on or off). Neither drivers nor license plates can be identified on the video recordings. The lateral position on the road surface (the position of the vehicle on the road surface laterally) was measured

from video recordings of the lateral position of the vehicle's right front tire on the road approximately 5 m before it passed the test car.

Results. When the stationary test car had its rear lights lit, the average lateral position of the passing vehicles was $M = 5.48$ cm ($SD = 1.46$ cm); with rear lights unlit, the average lateral position was $M = 5.20$ cm ($SD = 1.46$ cm), $t(848) = 2.33$, $p < .05$, $d = 0.16$. Converted from measurement on the monitor to reality (on the road surface), the average lateral position was about 9 cm further to the left when the test car's rear lights were lit. At sunrise, $n = 169$ (28%) of passing vehicles had unlit rear lights, while at sunset, $n = 19$ (23%) had unlit rear lights. During the day, $n = 48$ (59%) had their rear lights off.

3 Questionnaire Survey

The *purpose* was to investigate why passing vehicles pass laterally farther from a stationary vehicle with lit rear lights. In addition, car drivers' attitudes to lit and unlit rear lights in daylight, and the knowledge of current legislation on the use of rear lights, were investigated.

Method. *Participants* for the survey study were recruited via advertisement on social media 11–17 May 2023 and via VTI's own website, aimed at users aged 18 and over, throughout Sweden. In addition, the Swedish Homeowners Association advertised on 22 May 2023 via their monthly member email to approximately 19,000 members. In the opening text of the questionnaire, it was stated that the person who would participate in the study needed to have a valid passenger car driver's license. The social media advertisement reached 52,480 users and was shown an average of 1.87 times per user. N = 9282 respondents aged 18–100 years (M = 60 years 4 months, SD = 12 years 7 months) answered the survey, of which 30.4% women, 69.0% men and 0,5% who did not want to state gender, from all of Sweden's counties.

The respondents were randomly allocated to *the four questionnaire versions* via a web link on VTI's website. For between-group comparisons, video and still images of the test car were shown with either the rear lights lit, or unlit. For within-group comparison, video and still images were shown where the test car had the rear lights both lit and unlit, and in two different presentation orders. In all questionnaire versions, video was shown without sound, filmed from inside a car that passed the test car. The video was recorded on a test track without other traffic, in a right curve so that the test car was not visible from the beginning. The purpose of the design was to first examine how the respondents pay attention to and estimate overtaking when they were unaware that the study is about a difference between lit and unlit rear lights, and to also (with within-group comparison) examine how they assess the difference depending on whether the rear lights were on or not. The purpose of the final block of questions was to investigate attitudes, how they think they use their rear lights themselves, and the level of knowledge regarding the use of rear lights. For all estimates of visibility, clarity, and risk, 101-point (0–100) visual analog scales were used, with 50 as the midpoint (e.g., no difference between video clips). The direction of the rating scales was consistent with the order of the video clips, so that the order of presentation with rear light lit and unlit was reflected in the rating

scales. Before the analyses, these rating scales were therefore inverted for those who received the On–Off presentation order, in order to align all rating scales.

Results. It was judged to be slightly but significantly more likely that the stationary car would swerve out if it had its rear lights lit, see Table 1. This explains why the passing vehicles in the field experiment kept farther from the stationary test car when it had its rear lights lit. In contrast, rear-light status does not seem to make a difference to how clearly visible an observer thinks the car is – when there is no other car, with contrasting rear-light status, to compare with.

Table 1. Between-group comparison of car drivers' estimates as an effect of rear-light status.

	Lit rear lights			Unlit rear lights				
Survey question	*n*	*M*	*SD*	*n*	*M*	*SD*	*t*	*d*
After video with one passage (on *or* off)								
8. How *visible* do you think the stationary car was?	2202	59.74	24.06	2146	59.91	25.33	0.23	
9. How *clearly* could the car be seen?	2202	59.40	24.29	2142	59.93	25.09	0.71	
10. How likely was it that the car would *swerve out*?	2202	45.10	21.63	2146	40.43	22.18	7.03***	0.21

***$p < .001$.

As seen in Table 2, the mean values of all estimates differed significantly from the midpoint of the scale, meaning that rear-light status difference consistently had an effect. Passing the test car was judged to be safer when the rear lights were unlit. This is also consistent with the fact that lit rear lights was estimated to entail a greater risk for swerving out, and the greater lateral-position difference in the field experiment. Lit rear lights were also estimated to provide better visibility and safety – even though the vehicle passage in the video clip was judged to be somewhat safer when the rear lights were switched off.

Are you aware if you yourself drive with your rear lights on or off during the day when the light conditions do not require it by law? Of the $n = 3{,}279$ respondents, 76.2% stated that they drive with their rear lights on, while 16.8% stated that they drive with their rear lights off, and 7.0% stated that they do not know if they have their rear lights on or off during day time.

Do you prefer cars that have their rear lights on or off during the day? Of the $n = 3{,}279$ respondents, 84.4% indicated that they prefer on, while 1.6% indicated that they prefer off, 12.3% indicated that they think there is no difference, and 1.7% indicated that they don't know what they think on the matter.

Which lighting configuration do you think is safest during the day? Of the $n = 3{,}271$ respondents, 87.0% stated that they think that switching on the rear lights is safest during the day; 1.5% indicated that they think rear lights switched off are safest during the day;

Table 2. Car drivers' estimated differences of rear-light status (Unlit–Lit) against the null hypothesis that there is no difference (which corresponds to $\mu = 50$).

Survey question	*n*	*M*	*SD*	*t*	*d*
After video with both passages (on–off; off–on)					
8. Which overtaking was the *safest*? (1–2)	3756	45.04	27.28	11.15***	0.18
9. In which clip was the car most *visible*? (1–2)	3748	64.19	31.53	27.55***	0.45
10. In which clip… Risk that the car would *swerve out*? (1–2)	3737	64.30	32.78	26.67***	0.44
After text about rear-light status, with still image of the difference					
12. Which rear-light configuration was *safest*? (off–on)	3381	52.14	40.21	3.09**	.05
13. Which rear-light configuration was *most visible*? (off–on)	3376	84.98	22.17	91.67***	1.58
14. Which rear-light configuration was *clearest*? (off–on)	3377	72.63	32.07	41.01***	0.71

**$p < .01$ ***$p < .001$.

8.7% that they think lit and unlit rear lights are equally safe; while 2.8% stated that they do not know what they think about the matter.

Do you know what the law says about daytime running lights? Of the $n = 3{,}276$ respondents, 60.5% answered yes, while 39.5% answered no. This shows that a large percentage of Swedish drivers consider that they do not know the law on the use of rear lights.

4 Observational Study

In order to map more exhaustively the proportion of passenger cars and trucks in categories M1 and N1 that are driven without visibly lit rear lights in daylight, and in sunny weather during summertime, surrounding traffic was observed during car journeys in southern Sweden on 18 July 2023 and 22 July 2023 on the E4 motorway between Mantorp and Ljungby, and 28 July 2023 on the E22 between Kristianstad and Sölvesborg. Of the N = 794 cars, n = 143 (18%) clearly had lit rear lights, while for n = 49 cars (6%) it could not be judged whether the rear lights were on or whether it was the lamp glass that retroreflected the sunlight, and n = 602 cars (76%) clearly appeared to have unlit rear lights. The percentage of cars that did not have rear lights clearly switched on was thus 82% (n = 651 cars).

5 Discussion

The majority of Swedish drivers do not have lit rear lights by daylight, although they think they do. A large percentage stated that they do not know what the law says about rear lights during the day. The vast majority also prefer that surrounding traffic should have their rear lights on, because they think that the vehicles are then more clearly visible, that it is safer, and that it is easier to determine whether the vehicles are moving – which, for example, increases the perceived likelihood that a vehicle may suddenly start driving when you are about to pass it. This is also reflected in that drivers keep a greater distance laterally when passing a stationary car with lit rear lights.

Lit rear lights on vehicles, in daylight, is therefore highly desirable from a traffic-safety point of view. The recommendation is that the current EU legislation on the use of rear lights be reviewed and revised, to make it mandatory to have lit rear lights with sufficient brightness to be seen even in sunny weather.

References

1. SFS 1998:1276: Trafikförordningen [The Swedish traffic regulation] (n.d.). https://www.riksdagen.se/sv/dokument-och-lagar/dokument/svensk-forfattningssamling/trafikforordning-19981276_sfs-1998-1276/#K4
2. SOS International: Osynliga bilister fara i trafiken [Invisible drivers are a traffic hazard], 28 January 2019. https://www.sos.eu/se/nyheter/2019/osynliga-bilister-fara-i-trafiken/
3. European Parliament: Answer given by Ms Bieńkowska on behalf of the Commission. Parliamentary question: Answer to question E-008047/14, 5 June 2018. https://www.europarl.europa.eu/doceo/document/E-8-2018-001565-ASW_EN.html
4. European Parliament: Answer given by Ms Bieńkowska on behalf of the Commission. Parliamentary question: E-008047/2014(ASW), 29 April 2016. https://www.europarl.europa.eu/doceo/document/E-8-2014-008047-ASW_EN.html
5. TNO: Daytime running lights, deliverable report 3: Final report, TNO human factors. Contract Number: ETU/B27020B-E3-2002-DRL-S07.18830 (TREN/E3/27-2002) (2003). http://resolver.tudelft.nl/uuid:455c9087-e924-4ae7-bd34-6746d740e9fd
6. M Sverige [M Sweden]: Släckta bakljus en trafikfara [Lit rear lights a traffic hazard], 7, October 2020. https://msverige.se/sa-tycker-vi/nyheter/slackta-bakljus-en-trafikfara/
7. M Sverige [M Sweden]: 5 procent kör med släckta baklyktor i mörker [5 percent drive with unlit rear lights in darkness], 30 March 2021. https://msverige.se/sa-tycker-vi/nyheter/5-procent-kor-med-slackta-baklyktor-i-morker/

Open Access This chapter is licensed under the terms of the Creative Commons Attribution 4.0 International License (http://creativecommons.org/licenses/by/4.0/), which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if changes were made.

The images or other third party material in this chapter are included in the chapter's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the chapter's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.

