

Disability and Discomfort Glare of Headlamps

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Keywords: disability glare, discomfort glare, Xenon, LED headlamp

1 Abstract

In two studies the influence of different headlamp systems on disability and discomfort glare has been quantified. If the legal requirements were fulfilled the visual performance of the drivers was nearly identical for all systems (Xenon, Halogen, reflection systems, projection systems, LED headlamps). Discomfort glare varied slightly if the driver was looking at his own lane. The visual performance decreased dramatically as soon as the legal requirements were not fulfilled. In these situations discomfort glare raised to a high amount.

2 Experiments

In two runs of experiments the influence of different parameters on disability and discomfort glare was assessed. In a first study headlamps which fulfill the legal requirements were tested. In a second study misaligned and manipulated headlamps were examined.

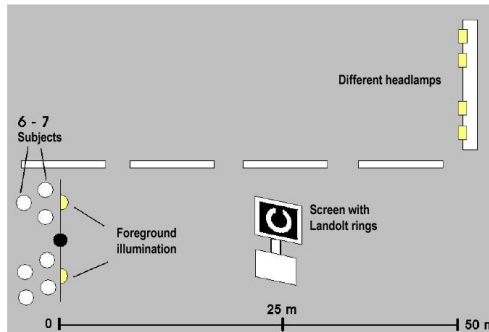


Figure 1: Test setup

2.1 Study I

The experiments were done in the light testing facility of the Hella company in Lippstadt (Germany). The test persons found themselves in a typical driving situation: sitting in their car in a driving position and being glared by oncoming traffic in a distance of 50 m (Figure 1). In front of the subjects there was a pair of Halogen headlamps to illuminate their own foreground. On the oncoming lane the glare sources were installed in point B50L. Seven subjects could be tested at a time.

The glare sources were:

- Halogen reflection system
- Halogen projection system
- Xenon projection system
- LED headlamp prototyp I
- LED headlamp prototyp II

All headlamps were calibrated in a way that the illuminance at the eyes of the test persons was 0.4 lx (included the foreground illumination). In preliminary tests this has been assessed as a typical value. The visual performance of the subjects depending from the glare situation was assessed by measuring threshold contrasts. 25 m in front of the test persons a screen was placed on the lane. On this screen Landolt rings were shown in different contrast stages. Each subject had a response board with eight buttons to mark where the gap of the ring was. For each subject and each glare source the individual threshold contrast could be assessed in this way. High contrast means low visual performance and vice versa.

The results are shown in figure 2. There are only very slight differences. If the legal requirements are fulfilled the visual performance of glared drivers is nearly identical for all glare sources [cf. 1].

In further tests discomfort glare was assessed as well.

It was important to ensure that the test persons did not look directly into the headlamps but on their own lane. Therefore letters were shown on the screen. Subjects had to press a button if a special symbol appeared. The glare sources

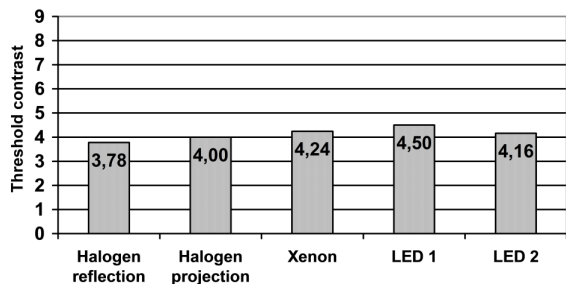


Figure 2: Disability glare Study I

were activated simultaneously.

After each trial the test persons used a slider at the response board to adjust how much they felt glared. Afterwards these values were calculated into the DeBoer scale.

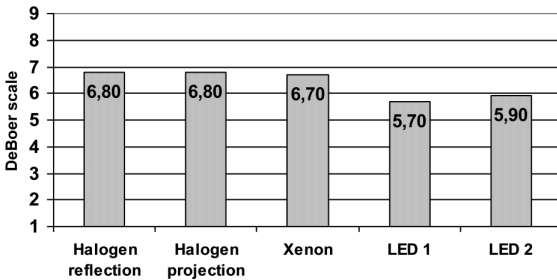


Figure 3: Discomfort glare Study I

Figure 3 shows the results. In the DeBoer scale high values mean low discomfort glare and vice versa. Two results are remarkable. There are no differences between Xenon and Halogen systems if the driver does not look directly into the glare source but on his

own lane. The LED headlamps were rated as one stage more glaring. But note that the LED headlamps used here were prototypes of the first generation.

2.2 Study II

The structure of study II was parallel to study I. But the glare sources used in study II did not fulfill the legal requirements. Hence the illuminance at the eyes of the subjects varied strongly.

A Halogen reflection system was misaligned in a way that the illuminance at the eyes of the subjects was 1.5 lx. This value has been found as realistic in former field studies. A blue “tuning foil” was affixed on the lens of a further Halogen projection system. In an internet shop an illegal “Xenon upgrade set” was bought. The bulb of a third Halogen reflection system was replaced by the gas discharge lamp. The Xenon projection system of the study I was used as a reference system. Additionally the threshold contrast was assessed without glare source (but with foreground illumination).

Thus the following situations were evaluated (in parentheses the illuminance at the eyes of the subjects, foreground illumination included):

- Halogen reflection system misaligned (1.5 lx)
- Halogen reflection system with „tuning foil” (1.82 lx)
- Halogen reflection system, Xenon upgrade illegal (1.58 lx)
- Xenon projection system (0.40 lx)
- no glare source (0.22 lx)

The results concerning disability glare are shown in figure 4. The threshold contrast for the Xenon projection system is nearly identical with the value in study I. This proved the reliability of the experimental setting. Without a glare source the threshold contrast decreases from 4.23 to 3.33. The results for the headlamps which do not fulfill the legal requirements are particularly interesting. The threshold contrasts increases dramatically. That means the visual performance decreases vastly [cf. 2].

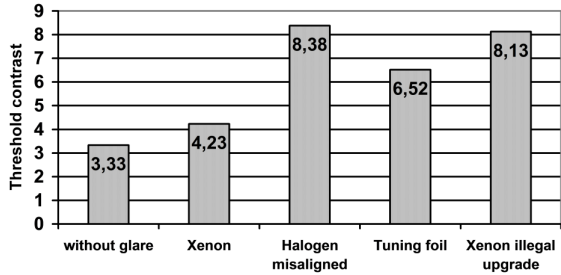


Figure 4: Disability glare Study II

Another way of expression may illustrate the facts. Reciprocal contrast values yield a level of sensitivity. Assuming a threshold contrast of 3.33 stands for 100% visibility for the situation without glare, visibility go down to approx. 80% if the glare comes from a vehicle with a Xenon system and to approx. 40% if the glare comes from a misaligned or manipulated headlamp.

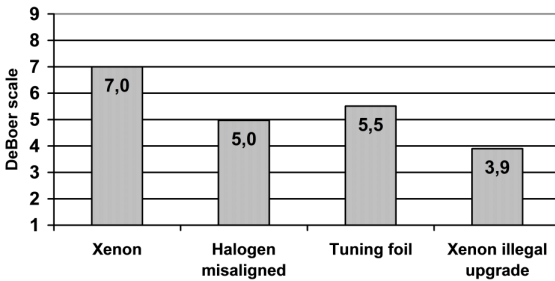


Figure 5: Discomfort glare Study II

performance decreases. Also discomfort glare increases strongly.

The results for discomfort glare are shown in figure 5. It is hardly possible to compare these values with those from figure 3 because very different stimuli establish a new internal reference system for the subjects. If the legal requirements are not fulfilled not only the visual

3 Conclusion

There are no differences in disability glare between different headlamp systems (Halogen, Xenon, LED, projection, reflection) if an oncoming cars headlamps fulfill the legal requirements. The visual performance of the glared driver is nearly identical in all these cases, although discomfort glare may vary. Headlamps which do not fulfill the legal requirements are dangerous! Reasons for a possible misa-

alignment can be: the Halogen bulb is not inserted correctly or the driver forget to adjust the manual headlamp leveling control and – of cause - by an illegal manipulation of the headlamp. Here is an urgent need for action because this is an important source of danger in nighttime traffic.

In this study no difference was found in discomfort glare between Halogen and Xenon systems. Why there are often complaints about Xenon systems? In the study the test persons were forced to look on their own lane. Maybe many drivers are looking directly into the headlamps of oncoming cars in real traffic. Projection systems (Xenon and Halogen) have higher luminances at the cover lens and this may raise more discomfort glare in such cases. Many drivers may confuse Halogen projection systems with Xenon systems and people may mistake misaligned or manipulated headlamps for Xenon systems. Both reasons are assumptions at the moment and have to be validated. It is important to inform drivers that Xenon systems increase safety: they guarantee to maintain the legal requirements in the long run and there is no more disability glare compared to Halogen headlamps.

4 References

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