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Czech Drivers' Glare Perception Survey

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Abstract: Worldwide, road-users complain about glare from oncoming cars' headlights, often blaming new light sources such as light-emitting diodes (LEDs). However, drivers' own behavior and attitudes might contribute to the issue of glare. The aim of this research was to establish the prevalence of on-road glare and its associations with drivers' attitudes in a sample of Czech drivers. We used an online survey and gained responses from 539 passenger-car-drivers. The majority experienced glare at least once a week or almost daily, identifying mainly white- or bluish-colored headlights as the source of glare. However, about 60% of participants would prefer the view of the road that is provided by these sources, and an association was found between the preferred part of the lighting color spectrum and the perceived glare source color. A large proportion of drivers were also not aware of the specifics of the lighting sources that they used. These findings suggest the need for driver education in the area of automotive lighting and glare prevention.

Keywords: automotive lighting; glare; perception; drivers; headlamps; LED; HID; halogen bulbs

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1. Introduction

For many years, on-road glare has been a concern among car-drivers and researchers in the field of traffic safety worldwide [1–18]. In a 2019 study of 1.215 drivers in the UK [2], about 60% reported regularly being dazzled by oncoming cars' headlamps, while they were not always able to tell the difference between low-beam and high-beam glare. Some of the drivers blamed the car type (i.e., sports utility vehicles (SUVs)) for this effect, while others complained about the lighting technology—especially xenon (also known as high-intensity discharge (HID)) lamps and the relatively newly used light-emitting diodes (LEDs).

Although they are two different technologies, LEDs and HIDs have some characteristics in common: compared to the halogen bulbs drivers used to encounter, HIDs and LEDs both differ in their spectral power distribution, intensity, flicker, and the surface area from which the light is emitted [3–7,11–13,15–17]. For a driver, the most apparent difference is in the perceived color of the light source, which seems whiter or even "bluish" in HID and LED car headlamps. This is partly due to the fact that the spectral power distribution of these sources, when used in automotive, has a distinctive peak in the blue–violet part of the (color) spectrum, which the halogen bulb does not [4–7,15–17,19–22]. Another contributing factor is the mounting of the sources within car headlamps: Whereas halogen bulbs are typically mounted in a reflector with a relatively large surface, HIDs and LEDs are usually part of a lens projection module (although exceptions exist). There, the light-emitting surface is much smaller and, due to the dispersion of light on the plastic optics used within the headlamp, unwanted effects such as blue color fringing might occur [3–7,10,17,23], both of which affect the driver's perception of glare. In addition, some drivers might be especially sensitive to bright light sources or the blue part of the color spectrum [7,11,14–16,18,21,22], which would further influence their perception of glare.

Of course, the characteristics of permissible car headlamps are regulated by international norms [24,25], so that *disability glare*—reduced contrast between objects caused by a high amount of light being scattered in the eye, effectively disrupting target detection by the

driver and thus influencing traffic safety—does not occur. Despite compliance to these norms, however, *discomfort glare* remains an issue. This is the subjective perception of visual discomfort, annoyance, or even distraction by the amount of light coming to the eye, leading drivers to experience various psychophysiological and behavioral responses [4,6–9,13–21,26].

Among these responses, narrowing the eyes or looking away from the light source might be the most common, as the participants in our laboratory research [26] reported. On the other hand, in this research, we observed a slight tendency of the drivers to blink less often with increasing stress levels, probably in an attempt to maintain their focus on the road as much as possible. However, in an older UK study [1], drivers reported that it takes them up to 5–10 s to recover from glare, i.e., to see clearly again, meaning that they could still miss about 70–140 m of the road if they only traveled at 50 km per hour. This poses a clear danger to traffic safety and is a reason to try to minimize glare by oncoming vehicles as much as possible—see also [11].

Of course, sometimes it is the behavior of the drivers themselves that causes increased on-road glare. Again, in the UK [2], about half of drivers admitted to not adjusting their headlights while carrying a heavier load, and some said that even if they suspect that they have misaligned headlights, they do not always try to fix the issue right away. Another problem is the use of retrofitted light sources (usually LEDs instead of halogen bulbs) in car headlamps that were not tested for these sources. As described above, halogen bulbs are usually mounted in a reflector, and putting an LED source in this system without properly testing the resulting light distribution properties can pose a significant risk of glare [15,27,28]. However, drivers are often not aware that such a risk exists and are under the impression that whatever they can buy at a gas station is legal for use in any vehicle.

The reasons that LEDs are so popular in automotive include their high energy-efficiency and longevity, higher subjective visibility from the perspective of the driver, and the possibilities they offer for headlamp designers in terms of shapes and functions (e.g., as adaptive headlights) [3–7,21,29]. Indeed, some car manufacturers make use of the distinctive spectral power distribution of LEDs by marketing the white-to-bluish light sources in car headlamps as "modern", "attractive", "desirable", etc. [29]. Additionally, the drivers themselves often admit that, even though they experience less glare from yellowish light sources, they would prefer a brighter white source in their own car, to illuminate the road ahead [4,6,8,12,30]. This creates a paradox in the drivers' behavior, potentially resulting in more glare encounters on roads.

Although driver complaints about glare can be found quite often, on various internet forums and news discussions, they only provide anecdotal evidence that some drivers might feel glare from the new light sources in car headlamps. We wanted to present more systematic, research-based evidence on the prevalence of glare on Czech roads, which could serve as a basis for the authorities responsible for on-road traffic safety, as well as for the car and headlamp manufacturers themselves. As, to our knowledge, no study of a similar scope to the ones in the UK [1,2] has been conducted in the Czech Republic, we wanted to determine how often Czech drivers encounter glare, which light sources seem to produce the most glare, which sources they have (or would like to have) in their own cars, and whether there is an association between these two aspects. We also wanted to understand the strategies that drivers use to prevent or mitigate glare, and assess their knowledge of and attitudes towards lighting technologies in cars. In our view, this information is necessary to make responsible, informed decisions regarding systematic countermeasures against on-road glare.

2. Materials and Methods

2.1. Data Collection

As our main goal was to determine the prevalence of on-road glare in the Czech Republic, we opted for descriptive research. We chose the form of an online survey to reach a variable population of drivers. For data collection, we created a questionnaire, the wording of which can be found here: https://forms.gle/osCS83ZrBeG1sseN9

(accessed on 18 July 2022, in Czech, i.e., the native language of the respondents). Likert-type items, multiple-choice items, and open-ended questions were used. The questionnaire was divided into multiple sections, asking for information related to:

- Demography (gender; age; region of residence; occupation—whether the participants work in the automotive or lighting industry);
- Vision (eye defects; whether the participants wear contact lenses or glasses and, if so, whether these have a blue-light filter; what colors do they prefer—"warmer (i.e., yellow, orange)/colder (i.e., white, blue)");
- Driving (vehicle type, incl. a bicycle—a separate set of questions was displayed for cyclists; years of driving experience; average monthly mileage; types of roads used; frequency of driving during nighttime/poor visibility conditions such as rain, fog, etc.);
- Car lighting (light source in their most-used car's headlamps; how often do the drivers check that their headlamps are working correctly; how much their headlights illuminate the road ahead—"not enough/enough/more than needed/they are glaring"; whether they know and/or have adaptive headlights; which view would they prefer related to headlight performance—see Figure 1);
- Glare (how often do the drivers experience glare—"almost never/a few times a year/at least once a month/at least once a week/almost daily"; by which vehicle and headlight types do the drivers feel dazzled the most often—e.g., "older cars/newer cars/don't know", "passenger cars/SUVs/vans/trucks/none/don't know", "low beams/high beams/don't know", "orange lights/yellowish lights/white lights/bluish lights/other"—in this case, the lighting color was assessed in two separate items, one using these verbal descriptors and the other using pictures of yellowish, white, and bluish light circles, where the participants were asked to indicate the color of the light that leads to glare the most often, or state that they "don't see a difference").

(**a**) (**b**) (**c**)

Figure 1. Item assessing the preferred view of drivers, simulating the use of (**a**) a halogen bulb reflector; (**b**) an HID lamp; (**c**) an LED source. The drivers had to choose one of the pictures based on their preference or indicate that they "don't see a difference" between the options.

Regarding glare, the drivers were also asked about situations in which they perceive glare to be the worst (e.g., "the oncoming vehicle doesn't dip the high beams/the oncoming vehicle's headlights are misaligned/the oncoming vehicle has a certain type of headlights/being dazzled by the vehicle behind me, i.e., through the rear-view mirrors/other") and what they do to prevent or mitigate the effects of glare (open-ended question).

At the end of the questionnaire, the drivers filled out a set of (mostly) "yes/no/don't know" items:

- Are you willing to pay extra for a higher level of headlight equipment?
- Do you consider better headlights to be an integral part of optional extras?
- Would you be willing to pay extra for headlights with demonstrably higher visibility?
- If headlights with demonstrably higher visibility caused glare to oncoming drivers, would you buy them?
- Would you be willing to buy more powerful headlights from optional equipment if it were possible to get a discount on car insurance?
- Do you think that driving with one non-functional headlight (low beam) allows you to drive as safely as when both headlights are on?
- Do you mind if you meet a car with one non-functional headlight (low beam) on the road?
- Do you think that drivers in the Czech Republic use daytime running lights (DRL) correctly?

- Should drivers in the Czech Republic use regular low beams more often?
- In your opinion, should the light signature on the rear of the car also be lit in daylight mode?
- Would you buy a non-homologated (unauthorized) light bulb or LED from an online store to achieve a higher level of visibility or aesthetic effect, even if it were to the detriment of oncoming drivers?
- Do you use non-original accessories in your car?
- Do you think it is more dangerous ("not to see/to cause glare")?
- For you, what is more important ("to see/to not cause glare")?
- Do you think it is safer to ("see/not cause glare")?

These questions aimed to gain a deeper insight into the drivers' experience and attitudes towards various issues regarding lighting technologies in cars and traffic safety in general. However, they were meant as a set of "stand-alone" questions with the same answering format (to make them more user-friendly), rather than forming a later-to-be standardized questionnaire. Altogether, the questionnaire took about 20–30 min to fill out. Data were collected for 10 months, from the beginning of February 2020 to the end of November 2020, with the intention of capturing possible changes in glare perception due to the summer/winter seasons. However, no such changes were observed.

2.2. Participants

The participants were recruited using snowball sampling. In total, 606 respondents filled out the questionnaire during the aforementioned time period. Of these, 46 were cyclists, and were, therefore, analyzed separately (not presented here). Of the remaining 560 participants, 3 did not give consent to use their data and 4 stated a lower age when acquiring a driver's license than the number of years they have been actually driving; these participants were removed from the data analysis. Upon suggestion, we also removed the responses from 14 participants identifying themselves as truck, bus, motorcycle, or moped drivers. Thus, the final sample consisted of 539 passenger car drivers; there were no missing data in their responses.

The sample consisted of 293 women and 246 men, aged from 18 to 80 years (M = 31.94; SD = 11.65), from all regions of the Czech Republic. The participants' driving experience ranged from 0 to 60 years (M = 11.59; Md = 8; SD = 10.63), and their average monthly mileage ranged from 0 to 120,000 km (M = 1363.54; Md = 650; SD = 5467.21). A total of 22 participants stated that they worked in the field of lighting technology (out of these, 17 worked in automotive lighting), and 17 more worked in the automotive industry. A total of 232 (43%) respondents reported no vision-related issues; from the remaining answers, myopia (n = 218) was the most frequent eye defect. Out of the 211 participants wearing glasses, 37 had a blue-light filter.

2.3. Data Analysis

The data were analyzed using descriptive statistics. Where appropriate, contingency tables and chi-square tests were used to test the following associations:

- Between the color preference of the drivers and the color of the headlights that they reported as dazzling them the most;
- Between the light source in the drivers' headlamps and the color of the headlights that they reported as dazzling them the most.

Responses from the open-ended questions were categorized based on their meaning, and a frequency analysis was performed.

3. Results

Out of the 539 survey participants, the majority drove at night "almost daily" (23%) or "at least once a week" (38%); only 14% reported driving at night "just a few times a year or less". More than half of the drivers stated that they encounter glare at least once a week or almost daily (see Figure 2). These encounters happen on all road types (within cities,

between cities, and on highways) with about the same frequency, meaning that the drivers do not perceive a specific type of road as being more prone to glare encounters.

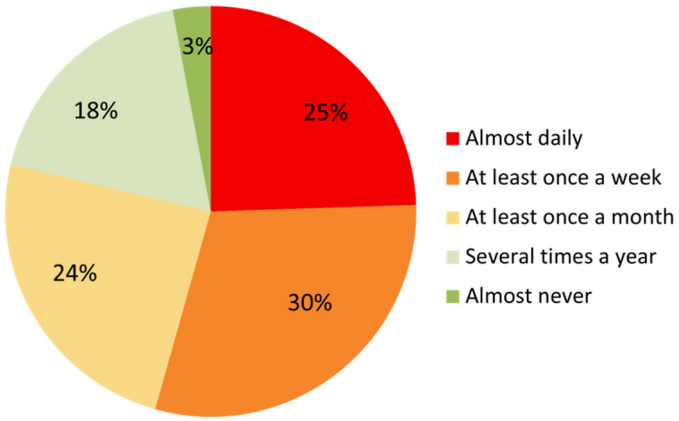

Figure 2. Responses to the question "How often are you glared by the oncoming traffic?".

Regarding the light sources that were perceived as causing the most glare, when asked about their color using a verbal descriptor, most drivers (86.5%) stated that they were "white or blue", followed by "yellow" (11.3%), "orange" (1.1%), and "all of them" or "not sure" (1.1% in total). When pictures of a yellowish, white, and a bluish light circle were shown, the results were similar, with most of the participants indicating the bluish circle (66.2%), followed by the white circle (18.4%) and yellow/orange circle (10.2%), and 5.2% stating that they "did not see a difference". Some drivers (6.9%) were also unable to distinguish whether they usually experienced visual glare from a high beam or a low beam, while others mentioned the high beam (48.8%) a little more often than the low beam (44.3%).

Given the option to choose between the vehicle types that were most prone to cause glare, passenger vehicles were mentioned slightly more often than SUVs, followed by vans and trucks (see Table 1). The drivers claimed to experience more glare from rather "new cars" (74.2%) than "old cars" (10.7%), with 15.1% of participants choosing the "I do not know" option. Therefore, we wanted to determine whether there was an association between the drivers' own headlamp light sources, or lighting color preferences, and (at least) the color of the headlights that led to glare.

Table 1. Responses to the question "By which vehicle type(s) are you usually glared?" (absolute frequencies; multiple responses possible).

Passenger Vehicles	SUVs	Vans (Light Commercial Vehicles)	Trucks	I Do Not Know	None
355	304	165	133	24	5

The participants themselves mostly drove cars with halogen bulbs (66.8%), followed by HID (10.2%) and LED (9.3%) headlamps, but a large number (13.7%) did not know the light source with which their cars' headlamps were equipped. No association was found between the own headlamp light source and the perceived color of the source of glare when using the picture-based item (χ^2 (9, n = 539) = 13.39; p = 0.146). For the item with verbal descriptors, as mentioned earlier, a lot of participants stated that they experienced glare from "both white and bluish lights", and only a small number of drivers identified the glare source's color as being "orange"; therefore, we grouped the answers into three categories: "white/bluish", "orange/yellowish", and "other response". You can see the contingency table in Table 2; this time, the association was statistically significant (χ^2 (6, n = 539) = 23.622; p = 0.001). A relatively larger proportion of drivers with HID or LED headlamps reported experiencing glare from "orange/yellowish" lights than drivers

with halogen light bulbs, although, overall, "white/bluish" was the most-reported color leading to glare from light sources.

Table 2. Perceived lighting color of the glare source according the drivers' own headlamp light source.

Headlamp Type	White/Bluish	Orange/Yellowish	Other Response	Total
Halogen	326	32	2	360
HID (Xenon)	40	13	2	55
LED	38	12	0	50
I do not know	62	10	2	74
Total	466	67	6	539

When asked about their preferred view, simulating the respective light sources, 33% of participants indicated the picture simulating the halogen light bulb, 32% the HID, and 29% the LED source, while the rest reported "not seeing a difference". The association with the perceived color of the light source when using the picture-based item was statistically significant (χ^2 (9, n = 539) = 27.382; p = 0.001). Again, a relatively higher proportion of participants that preferred the view provided by LED sources reported experiencing glare from rather yellowish lights and, compared to participants that preferred HID or halogen headlamps, a lower proportion reported experiencing glare from bluish lights (see Table 3).

Table 3. Perceived lighting color of the glare source (picture-based item) according to preferred view.

Light Source (View)	Yellow	White	Blue	I Do Not See a Difference	Total
Halogen	14	37	122	6	179
HID (Xenon)	17	27	123	7	174
LED	23	28	94	8	153
I do not see a difference	1	7	18	7	33
Total	55	99	357	28	539

When using the item with verbal descriptors of the light-source color (Table 4), the results were rather similar, and also statistically significant (χ^2 (6, n = 539) = 32.00; $p < 0.001$).

Table 4. Perceived lighting color of the glare source (verbal descriptor item) according to the preferred view.

Light Source (View)	White/Bluish	Orange/Yellowish	Other Response	Total
Halogen	171	7	1	179
HID (Xenon)	150	20	4	174
LED	119	34	0	153
I do not see a difference	26	6	1	33
Total	466	67	6	539

Finally, when directly asked what part of the color spectrum the drivers usually prefer ("warmer, i.e., yellow, orange", or "colder, i.e., white, blue" colors), the same tendency for those who preferred colder lighting colors to experience glare from orange/yellowish light sources was manifested in both the picture-based item (χ^2 (3, n = 539) = 32.887; $p < 0.001$) and the item using verbal descriptors of glare-source lighting colors (χ^2 (2, n = 539) = 48.03; $p < 0.001$); see Tables 5 and 6, respectively.

Table 5. Perceived lighting color of the glare source (picture-based item) according to the preferred part of the color spectrum.

Color Spectrum Part	Yellow	White	Blue	I Do Not See a Difference	Total
Colder	30	32	74	12	148
Warmer	25	67	283	16	391
Total	55	99	357	28	539

Table 6. Perceived lighting color of the glare source (verbal descriptor item) according to the preferred part of the color spectrum.

Color Spectrum Part	White/Bluish	Orange/Yellowish	Other Response	Total
Colder	104	42	2	148
Warmer	362	25	4	391
Total	466	67	6	539

We also wanted to assess the strategies that drivers use to deal with glare. These are summarized in Table 7. As can be seen, the drivers understood the question "What do you do to prevent glare?" in three different ways, and the strategies are listed accordingly. Nevertheless, more than 30 drivers also reported doing nothing to prevent glare (these answers were not included in the table).

Table 7. Countermeasure strategies for glare prevention (absolute frequencies; multiple responses possible, yet not all participants gave an answer).

Situation	Countermeasure	Total
I feel dazzled by the oncoming traffic	I do not stare into the oncoming car's headlamps	76
	I flash my high beam	23
	I slow down	14
	I narrow my eyes	13
	I put on my glasses (with filter)	8
	I lower the sun visor	2
I feel dazzled by the cars behind me	I adjust the mirror/I have a filter on my mirror	36
	I let the car behind me overtake me	2
I do not want to glare other traffic	I turn off my high beam	158
	I regularly adjust the light distribution of my car	78
	I have adaptive headlamps	5
	I keep my distance from the car I follow	8

Surprisingly, only 17.8% of participants reported checking their headlights' functionality before each trip, while 21.7% checked this at least once a week, and 25.4% at least once a month. Another 12.4% checked their headlights at least once every half year or at least once a year (4%), but 18.7% admitted never checking if their headlamps are working correctly. In most cases, the drivers felt that their headlights illuminate the road ahead "enough", and that their headlights do not glare (see Table 8).

Table 8. Perceived road illuminance by headlamp type (absolute frequencies).

Headlamp Type	Not Enough	Enough	More Than Needed	Glaring	Total
Halogen	44	312	4	0	360
HID (Xenon)	3	51	1	0	55
LED	0	49	0	1	50
I do not know	10	64	0	0	74
Total	57	476	5	1	539

Finally, as the perceived prevalence of on-road glare might also be influenced by drivers' beliefs and attitudes, we asked a series of yes/no/don't know questions, the answers to which are summarized in Table 9. The questions covered a wider range of topics related to car lighting, traffic safety, and the drivers' behavior, experience, and convictions. Out of these, the most alarming may be the finding that not all drivers think that driving with, e.g., only one functional headlight or a non-homologated light bulb is unsafe, underestimating the risks of their own behavior regarding car lighting to traffic safety. When forced to choose one option, the majority (71.6%) of participants preferred

"seeing" to "not glaring", stating that "not seeing" is more dangerous (58.3%) than causing glare (41.7%).

Table 9. General questions about light and glare in the context of driving (absolute frequencies).

Question	Yes	No	I Do Not Know
Do you know the function of adaptive high-beam?	302	219	18
Does your vehicle possess adaptive (glare-free) high beam?	56	355	128
Are you willing to pay extra for a higher level of headlight equipment?	261	194	84
Do you consider better headlights to be an integral part of optional extras?	299	202	38
Would you be willing to pay extra for headlights with demonstrably higher visibility?	274	194	71
If headlights with demonstrably higher visibility caused glare to oncoming drivers, would you buy them?	40	445	54
Would you be willing to buy more powerful headlights from optional equipment if it were possible to get a discount on car insurance?	329	134	76
Do you use non-original accessories on your car?	102	413	24
Would you buy a non-homologated (unauthorized) light bulb or LED from an online store to achieve a higher level of visibility or aesthetic effect, even if it were to the detriment of oncoming drivers?	16	508	15
Do you think that driving with one non-functional headlight (low beam) allows you to drive as safely as when both headlights are on?	22	505	12
Do you mind if you meet a car with one non-functional headlight (low beam) on the road?	434	91	14
Do you think it is dangerous to drive with one non-functional headlight (low beam)?	455	67	17
Do you think that drivers in the Czech Republic use daytime running lights (DRL) correctly?	175	292	72
Should drivers in the Czech Republic use regular low beams more often?	337	93	109
In your opinion, should the light signature on the rear of the car also be lit in daylight mode?	363	126	50

4. Discussion

The aim of our research was to estimate the prevalence of on-road glare encounters from the viewpoint of Czech passenger-car-drivers. Our findings show that about $\frac{1}{4}$ of drivers on Czech roads encounter glare on a daily basis, and another 30% experience glare least once a week, irrespective of road type. These numbers are similar to those in the UK [1,2], where drivers were also unable to distinguish whether they were dazzled by high beams or low beams. However, in our research, only 6.9% of participants explicitly stated this; the rest were evenly split between those believing they experienced the most glare from high beams and those believing they experienced the most glare from low beams. In any case, the fact that low beams are perceived as being an equal source of glare to high beams is potentially disquieting.

One reason that low beams are perceived as being a similarly frequent source of glare to high beams might be the use of new light sources (HIDs, LEDs) in car headlamps. Indeed, some research suggests that specific characteristics of these sources, especially LEDs' spectral power distribution, which peaks in the blue part of the color spectrum, and the relatively small surface area of the LED source from which the light is emitted [3–5,15–17,21] might cause discomfort glare in drivers. In the studies of Bullough and colleagues [4,5] and Sivak and colleagues [15,16], bluer light sources (i.e., HIDs and LEDs) were rated as causing more discomfort glare than yellowish light sources (i.e., halogen bulbs). According to the tests performed by the ADAC [3], mounting LEDs in lens projection modules causes higher levels of glare than when the same source was mounted in a reflector system. Therefore, they recommend using reflector systems for low beams with LEDs, as is the case with halogen bulbs, similarly to [17].

Contrary to the drivers' convictions in previous research [1,2,17] and internet discussions, based on our survey results, it is not predominantly SUVs, vans, or trucks that are the most frequent cause of glare, but passenger cars. The issue of glare might, therefore, not simply be due to the (higher) mounting of car headlamps, as [17] suggests, but may also be due to their alignment and other driver behaviors. Although 29% of our respondents reported being cautious about their high beam use, only about 14.5% mentioned regularly adjusting the light distribution of their headlamps as a glare prevention measure, although this is repeatedly recommended by experts in the media [3,17]. However, these results are similar to the ones from the UK [1,2], where drivers also admitted not adjusting their headlights when carrying heavier loads.

Despite some newer vehicles trying to overcome the aforementioned issue by, e.g., using automatic headlamp leveling systems or adaptive high beams, it is important for drivers to be aware of their headlamps' functions and functionality. In this context, it is alarming that about 23.7% of our participants did not know whether they have adaptive high beams in their vehicles, and a further 13.7% were not even aware of the light source with which their headlamps were equipped. Further, more than 30% of our respondents admitted checking the headlights' functionality only once half a year or less (or even not at all). Some drivers even thought that driving with only one functional headlight or with a non-homologated light bulb is safe, which was disputed in some of the previous studies [27,28]. These findings call for drivers to receive a more in-depth education in the area of automotive lighting.

Nonetheless, one of our main findings addresses the seemingly paradoxical behavior of the drivers: although they complained about glare from mostly white or bluish light sources (i.e., HIDs or LEDs [3–7,12,13,15–17]), more than 60% of our respondents prefer the view of the road that is provided by HIDs and LEDs—similar to the results of previous research [6,8,12,13,17,22]. These studies conclude that newer light sources might provide the driver with better on-road visibility than the halogen light bulbs. However, when experiencing glare from the same, newer light sources from oncoming vehicles, drivers might experience higher levels of discomfort. Some researchers [21] tried to explain this phenomenon by the large inter-individual variations in brightness or spectral distribution sensitivity, stating that there might be groups of drivers that are especially sensitive to the color rendering of the headlamp light source. Indeed, we found that a larger proportion of those drivers who preferred colder colors or the view provided by LEDs and HIDs (as opposed to halogen bulbs) experienced glare from "yellowish" or "orange" light sources. However, the number of our respondents—more than 80%—that complained about glare from "white to bluish" lights seems too high for this to be the sole reason. Related to this issue, Muramatsu et al. [22] point out that "color preference as a subjective response discords from visual fatigue evaluated by biological information", and the underlying biological mechanisms of a discomfort glare perception are still under investigation [6,7,9,11,26].

Finally, we wanted to examine whether the light source in the drivers' own headlamps might play a role in the perception of discomfort glare, perhaps due to a form of adaptation [18]. If this was the case, we could expect that the more cars equipped with LEDs were on the roads, the less frequent glare complaints would become. However, we found no association between headlamp light source and the perceived color of the subjectively glaring light source when using the picture-based item; the association was only significant when using the item with verbal descriptors of glare-source colors. Similarly, our laboratory research results [26] did not show an adaptation effect in terms of a statistically significant interaction between the driver's light source and their response to glare from different light sources. Possible adaptation effects, therefore, pose an interesting topic for future research, as does the interaction between the drivers' lighting color preference and their reaction to glare.

Of course, there are some limitations to our current study. First of all, our research sample was not completely random, as we used convenience sampling and the snowball method for participant recruitment in the online study. Due to data protection regulations, we were not able to obtain access to a larger database of drivers and recruit our sample in a

more representative manner. This might have contributed to a slight over-representation of women, as well as younger age groups (mainly 20–30-year-olds) and certain regions of the Czech Republic, in our research sample. More truck-, bus- and motorcycle-drivers would also be needed to accurately represent these types of drivers in our sample; due to their low number, they had to be omitted from the analysis in this study. For the reasons, the results are not representative of the entire Czech driving population. Despite this obstacle, the demographical characteristics of our final sample still seem diverse enough to represent the general Czech passenger-car-driving population, although the possibility still exists that those drivers who encountered glare on a regular basis were more motivated to complete the questionnaire.

Further, data collection took place from February to November 2020, i.e., during the COVID-19 pandemic; therefore, due to lockdowns, drivers might not have traveled as often, especially at night-time, which might have influenced their responses related to glare-encounter frequency. Therefore, it would be beneficial to repeat the survey in a wintertime without pandemic-related restrictions and compare the results.

Finally, basing the survey on a more random sampling—such as by distributing the questionnaire to drivers upon their yearly car checkup—might help to overcome the concerns as to whether only drivers who are troubled by the issue of glare responded. In this matter—and also in terms of driver education and awareness—it would help if government authorities organized similar surveys in the future.

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Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki and was approved by the Ethics Committee of the Department of Psychology, Faculty of Arts, Palacký University Olomouc, Czech Republic.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available due to the formulations in the informed consent to which the participants agreed.

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Conflicts of Interest: Ladislav Stanke was an employee of the automotive lighting company Hella Autotechnik Nova, s.r.o., Mohelnice, Czech Republic, in the position of Lead Lighting Engineer during the initial phase of the project, with the aim of increasing collaboration between academia and the private sector, which was conducted as a collaboration between the Palacký University Olomouc and the Hella Autotechnik Nova, s.r.o., Mohelnice, Czech Republic. Stanke was mainly involved in the preparation phase of the questionnaire design. He was not directly involved in data collection and analysis, and the company employees, in general, did not affect data collection, analysis, interpretation, and/or publication in any way. Furthermore, the funders (TA ČR) had no role in the design of the study; in the collection, analysis, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

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