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Use of Advanced In-Vehicle Technology By Young and Older Early Adopters

Survey Results on Headlamp Systems



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16. Abstract This document describes the results of survey research undertaken by the Automobile Club of Southern California. Ten thousand questionnaires were mailed to insurance customers who own vehicles that may have high-intensity discharge (HID) headlamps or directionally adaptive headlamps as standard or optional original equipment. Half of the questionnaires were mailed to vehicle owners who were younger than 65, and half of the questionnaires were mailed to owners who were 65 or older. Approximately 21 percent of the questionnaires were returned, including 1,117 from HID headlamp owners. Follow-up telephone interviews were conducted with 34 respondents. Survey items addressed topics such as learning to use the system, behavioral adaptation, system effectiveness, and perceived safety of the system. Several differences in responses between younger and older respondents were noted. Other response differences were related to vehicle manufacturer and experience with the vehicle (miles driven). Study limitations and implications of the results are discussed.					
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TABLE OF CONTENTS

EXECUTIVE SUMMARY	1
PROJECT OVERVIEW: USE OF ADVANCED IN-VEHICLE TECHNOLOGY BY YOUNG AND OLDER EARLY ADOPTERS	7
Project Partners	7
Purpose.....	7
Project Scope	8
HID HEADLAMPS, ADAPTIVE HEADLAMPS, AND GLARE.....	9
Functional Characteristics of High-Intensity Discharge (HID) Headlamp Systems and Adaptive Headlamp Systems.....	9
High-intensity discharge (HID) headlamps	9
Adaptive headlamps.....	9
Headlamp Glare	10
DEVELOPMENT OF SURVEYS.....	12
Content areas.....	12
Telephone Interviews.....	14
Sampling	14
RESULTS	15
1. Response Rate.....	15
2. Classification of Responses by Type of Headlamps	15
3. General Characteristics of Survey Respondents	17
Age and gender	17
Vision conditions that may make driving at night more difficult	21
Respondents' vehicles.....	22
Driving experience with current vehicle	22
Frequency of driving when it is dark	23
4. Desire to Have HID Headlamps and Adaptive Headlamps	24
HID headlamps	25
Adaptive headlamps.....	25
5. Uncertainty Regarding Headlamp Type and Beam Pattern	26
6. Headlamp Glare	27
Checking or adjusting headlamp aim.....	27
Other drivers flashing their high beams.....	29
Experiencing glare from other vehicles' headlamps	32
Behavioral responses to headlamp glare	34
7. Behavioral Adaptation to Headlamps	35
8. Perceived Effectiveness of Headlamps	39
Visibility under four driving scenarios (with HID versus non-HID headlamps).....	40
Visibility under four driving scenarios (relation to headlamp beam pattern)	44
Visibility under four driving scenarios (relation to headlamp optics).....	44
Visibility under four driving scenarios (results from logistic regression models).....	45
9. Safety	48
Perceived safety of HID headlamps	48
Experience with collisions and near collisions due to headlamp glare	49
10. Need for Improvements to Headlamps	49

11. Meeting the Needs of Older Drivers	50
SUMMARY AND DISCUSSION.....	52
Summary of Findings.....	52
Survey samples	52
Uncertainty regarding headlamp type	52
Desire to have HID and adaptive headlamp technologies.....	52
Behavioral adaptation	53
Perceived effectiveness of headlamps.....	53
Safety and headlamp glare	54
Need for headlamp improvements and vehicle improvements	55
Summary of differences by age group	55
Study Limitations.....	57
Implications	58
REFERENCES	59
APPENDIX A: MAIL-OUT SURVEY INSTRUMENT AND RECRUITMENT LETTER	60
APPENDIX B: TABULATED SURVEY RESULTS FOR HEADLAMP SURVEY	71
APPENDIX C: DISCUSSION GUIDE FOR TELEPHONE INTERVIEWS WITH SELECTED RESPONDENTS TO THE HEADLAMP SURVEY	86
APPENDIX D: COMMENTS FROM TELEPHONE INTERVIEWEES	87

LIST OF TABLES

<u>Table</u>	<u>Page</u>
1. Headlamp systems questionnaire: Content areas and associated items	12
2. Reported HID headlamp status (Q16) by HID availability on vehicle model	16
3. Age group and vehicle manufacturer for respondents with HID headlamps	20
4. Vision conditions by age group (Q3)	21
5. All respondents by age and by experience with their vehicle	23
6. Respondents with HID headlamps by age and by experience with their vehicle	23
7. Respondents' desire to have HID headlamps by current headlamp type	25
8. Apparent lens type for HID headlamps and non-HID headlamps (Q14)	27
9. Apparent beam pattern for HID headlamps and non-HID headlamps (Q15)	27
10. Respondents who have had their headlight alignment checked by level of vehicle experience	28
11. HID and non-HID headlamp owners receiving high-beam flashes from other drivers	29
12. Respondents' perception of light from oncoming vehicles (Q10) by own headlamp type	33
13. Older respondents' perception of light from oncoming vehicles (Q10) by own headlamp type	34
14. I use the high beams less often than I would if I had conventional headlights. (Q22A) by age group	36
15. I use the high beams less often than I would if I had conventional headlights. (Q22A) by vehicle manufacturer	37
16. I am <u>more</u> willing to drive at night with my headlights than with conventional headlights. (Q22C) by age group	37
17. I am <u>more</u> willing to drive at night with my headlights than with conventional headlights. (Q22C) by vehicle manufacturer	38
18. "I feel less eyestrain driving at night with my headlights than with conventional headlights," (Q22B) by age group	40

LIST OF TABLES (CONTINUED)

<u>Table</u>	<u>Page</u>
19. “I prefer my headlights to conventional headlights,” (Q22E) by age group	40
20. “On curved roads, how easy is it for you to see lane lines using your low beams?” (Q9A) by headlamp type	41
21. “How easy is it for you to read overhead road signs that are not lighted except by your headlights’ low beams?” (Q9B) by headlamp type	42
22. On roads without street lights, how easy is it for you to see pedestrians on or near the road using your low beams? (Q9C) by headlamp type	42
23. When you approach a hill how easy is it for you to see the roadway up the hill ahead using your low beams? (Q9D) by headlamp type	43
24. Percentage of older and younger respondents with and without HID headlamps who said that it was “very easy” or “somewhat easy” to see in four visibility scenarios	44
25. Statistically significant model parameters for predicting “easy” to see responses in four visibility scenarios (all age groups)	46
26. Statistically significant model parameters for predicting “easy” to see responses in four visibility scenarios (older age groups)	47
27. Statistically significant model parameters for predicting “easy” to see responses in four visibility scenarios (younger age group)	48
28. Overall, does having your HID and/or adaptive headlights make you a safer driver than if you had conventional headlights? By vehicle manufacturer	49
29. Is there anything about your headlights you think should be improved? (Q20) By vehicle manufacturer	50
30. In general, do you believe that car manufacturers are doing enough to design their vehicles to accommodate an aging population? (Q24) By headlamp type	50

LIST OF FIGURES

<u>Figure</u>		<u>Page</u>
1.	Age and gender of all respondents to the headlamp survey	18
2.	Age and gender of respondents who have HID headlamps	19
3.	Age and gender of respondents who do not have HID headlamps	20
4.	Frequency of driving when it is dark outside by age group	24
5.	Respondents with HID and non-HID headlamps who report that oncoming drivers flash their high beams at them for three levels of vehicle experience	31

EXECUTIVE SUMMARY

This report describes the analysis of survey data collected by AAA Foundation for Traffic Safety in cooperation with the Automobile Club of Southern California. Vehicle owners who had high-intensity discharge (HID) headlamps or directionally adaptive headlamps were surveyed along with those who did not have these technologies. These two headlamp technologies are still relatively new and are not widely available within the U.S. passenger vehicle fleet. The purpose of the study was to learn about early adopters' experiences using these headlamp systems and to gauge the extent to which glare from other drivers' headlamps may be a problem for drivers equipped with HID and non-HID headlamps. Some specific areas of interest included drivers' acceptance of the systems, headlamp glare, perceived effectiveness and usability of the headlamp systems, and behavioral adaptations which may occur with the change from conventional (halogen) headlamps to HID headlamps. An overarching goal of the study was to learn more about the extent to which advanced headlamp systems may support older driver's capabilities. A major focus of the data analysis was comparing responses between older drivers (65 or older) and younger drivers (younger than 65). It is possible that new technologies such as HID headlamps can assist older drivers to drive more safely with less stress, thus extending their safe driving years, or allowing them to continue to drive safely at night. It is also possible that advanced headlamps may cause unintended consequences such as over-reliance on the technology or unsafe levels of glare for other drivers. However, generalizations about HID versus halogen headlamps must be considered carefully because not all halogen headlamps are the same and not all HID headlamps the same. For example, the beam patterns produced by both headlamps types depend on the design of optical elements in the lamp housing in addition to the type of light source.

Survey Method

Questionnaires were mailed to 10,000 potential HID headlamp or directionally adaptive headlamp owners. The sample was selected by Automobile Club of Southern California (ACSC) from its database of insurance customers. Only owners of particular vehicle makes and models known to have HID headlamps or adaptive headlamps as a standard feature or available option were invited to participate. Half of the questionnaires were mailed to vehicle owners who were 25 to 64 years old and the other half were mailed to vehicle owners who were 65 or older. Respondents were asked to mail back the questionnaire to ACSC in a self-addressed postage-paid envelope even if they did not have HID or adaptive headlamps. Approximately 21 percent of the questionnaires were returned. Based on self-reports and knowledge of available and standard vehicle equipment, 1,117 respondents were classified as having HID headlamps and 434 were classified as not having HID headlamps. These two groups were compared. Respondents with HID headlamps tended to be younger than those with non-HID headlamps, although these groups did not differ significantly by gender or by experience level with their vehicles (miles driven).

In addition to the written questionnaires, ACSC staff conducted brief telephone interviews with 34 respondents to gather additional information about their experiences with their headlamps and their suggestions for vehicle improvements.

Key Findings, Limitations, and Implications

The survey methodology used in this study was an efficient way to assess a large number of drivers' knowledge and perceptions about headlamp technologies. It also provided insights into how the headlamps may be affecting driver behavior.

Knowledge of headlamp light source

Drivers do not necessarily know what type of light source their headlamps use. For example, 18 percent of survey respondents did not know whether they had HID headlamps and 20 percent did not know whether they had adaptive headlamps. Women were more likely than men to say that they didn't know, and older respondents were more likely than younger respondents to say that they didn't know.

Effects of headlamp type

In addition to the type of headlamp light source (HID versus non-HID), respondents were asked to report information about whether their headlamp beam pattern had a sharp cut-off, and whether their headlamps used projector optics. While the responses to several items on the survey depended significantly upon whether or not respondents had HID headlamps, responses to fewer items depended significantly on whether or not respondents had projector optics or a sharp cut-off beam pattern. For those specific situations in which significant differences were found, respondents who said they had HID headlamps and headlamps with a sharp cut-off beam pattern found it easier to see than did respondents without these headlamp attributes.

Desire to have HID headlamps

Eighty-eight percent of respondents who were classified as having HID headlamps said if they purchased their same vehicles again, they would want to get the technology, and 75 percent of respondents with HID headlamps said they preferred HID headlamps to conventional headlamps. Among those who do not have HID headlamps, only 23 percent said they would want them. The most common reasons cited for not purchasing HID headlamps were related to availability on the specific vehicles they purchased or lack of knowledge about the system. Nearly 17 percent of respondents said they didn't choose to get HID headlamps because they thought they would be a nuisance or distraction to other drivers, whereas cost was cited as a reason by only 7 percent of respondents.

Visibility with headlamps and preference for HID headlamps

HID headlamp owners generally preferred HID headlamps to conventional headlamps and younger respondents were generally more enthusiastic about their HID headlamps than were older respondents.

The vast majority of HID headlamps owners seemed to find them effective at helping them to see in several specific nighttime driving scenarios. Specifically, owners of HID headlamps were more likely than owners of conventional headlights to say that it was easy for them to see lane lines on curved roads (Q9A), overhead signs (Q9B), pedestrians (Q9C), and the roadway ahead when approaching a hill (Q9D).

Logistic regression analyses were used to investigate the combined influence of several possible predictive variables on whether respondents said seeing was "easy" in the four visibility scenarios (Q9A-Q9D) mentioned above. Age group was an important predictor of easy-to-see

responses; younger respondents were more likely to say “easy” than were older participants when controlling for headlamp type, beam pattern, and headlamp optics type.

For older respondents, having HID headlamps was associated with “easier” reported seeing in scenarios Q9A – Q9C. Having projector optics was associated with fewer easy-to-see responses for scenario Q9C (pedestrians).

For younger respondents, having HID headlamps was associated with easy-to-see responses for seeing in scenario Q9C (pedestrians), but not for the other three scenarios. Having a sharp cut-off beam pattern was associated with easy-to-see responses for scenarios Q9A (curved roads) and Q9C (pedestrians).

Behavioral adaptation

Nearly a quarter of both older and younger respondents with HID headlamps said they are willing to drive faster with their headlamps as compared to conventional headlamps, and when asked how their driving behavior would change if their HID headlamps were replaced with conventional headlamps, nearly 18 percent of respondents said they would drive more slowly at night.

Several items addressed the possibility that having HID headlamps may increase the amount of nighttime driving. A large minority (40%) of HID drivers agreed or strongly agreed that they are *more willing* to drive at night with HID headlamps than with conventional headlamps, and younger respondents were more likely than older respondents to strongly agree. However, for younger drivers and for older drivers, the *reported frequency of driving* while it was dark outside did not depend significantly on whether the respondent had HID headlamps or not. When asked, “If your headlight system had to be replaced with conventional headlights, how would your driving behavior change?” only 9 percent said they would limit *the amount of nighttime driving*, and approximately 70 percent of those with HID headlamps said their behavior would not change. Some said they would limit where or when they drive by avoiding unfamiliar places at night (10%), or by avoiding dark roads (11%).

Safety and glare

Fifty-seven percent of HID headlamp owners said they are safer drivers because they have this technology. However, many HID headlamp owners were aware that their headlamps sometimes cause glare problems for other drivers. Over 18 percent of HID headlamp owners reported at least occasionally receiving high-beam flashes from other drivers while their own low beams were on, compared to only 10 percent of non-HID headlamp owners who reported this.

Logistic regression analyses showed that when controlling for age group, gender, beam pattern, and headlamp optics, headlamp type (HID or non-HID) was a significant predictor of whether respondents reported receiving high-beam flashes from other drivers. In another logistic regression model that included headlamp type (HID or non-HID), vehicle manufacturer (Acura, Audi, BMW, Mercedes-Benz, Nissan, and Toyota), age group, and gender, only headlamp type (HID versus non-HID) was a statistically significant predictor of reporting high-beam flashes from other drivers.

Checking and adjusting headlamp aim may be especially important for HID headlamp owners who have 30,000 (or more) miles on their vehicles. While driving with low beams on, this group of respondents had the highest probability of receiving high-beam flashes from other

drivers. Among vehicle owners who do not have HID headlamps, 17 percent said one reason for not purchasing HID headlamps was because they thought HID headlamps would be a nuisance or distraction to other drivers.

Suggested improvements

HID headlamps owners and non-HID headlamps owners had similar suggestions for improvements to their headlamps. The three most frequent suggestions were to provide wider coverage, to improve the beam to reduce the glare to other drivers, and to increase the level of automation of the headlamp system, such as providing lights that automatically change based on traffic and weather conditions.

Several differences were found between younger and older respondents, and in some cases responses depended on the respondent's level of experience with the vehicle.

Differences between younger and older respondents

As compared to younger respondents, older respondents:

- Tended to have less driving experience with their current vehicles and reported driving less often when it is dark.
- Were more likely to wear glasses (less likely to wear contact lenses) and to report having cataracts or cataract surgery (less likely to have had Lasik surgery).

Older and younger respondents' perception of light (glare) from other vehicles was similar, although older respondents who have HID headlamps were more likely than older respondents with non-HID headlamps to find light from oncoming vehicles acceptable. There were differences between age groups in the way that respondents said they deal with glare from other vehicles. Younger respondents were more likely than older respondents to use active strategies such as blocking the light with their hands, while older respondents were more likely than younger respondents to limit their driving at night and to avoid unlighted two-lane roads.

Among respondents who have HID headlamps, younger respondents were more likely than older respondents to strongly agree with the following statements:

- "I use the high beams less often than I would if I had conventional headlights";
- "I feel less eyestrain driving at night with my headlights than with conventional headlights";
- "I am more willing to drive at night with my headlights than with conventional headlights"; and
- "I prefer my headlights to conventional headlights."

The proportion of respondents who agreed versus disagreed with the statement, "I am willing to drive faster using my headlights' low beams than with the low beams from conventional headlights," did not differ significantly between age groups.

The proportion of respondents with HID headlamps who felt that the headlamps made them safer drivers did not differ significantly between age groups.

Study Limitations

- There are some inherent weaknesses associated with self-reported data. Self-reports can be unreliable, especially where respondents need to rely on memories of past events or where respondents may have certain expectancies about giving answers that they believe the researchers “want” to see. It is possible that household members other than the intended respondent completed some questionnaires or that a respondent answered the questionnaire based on experience with a vehicle other than the one specified.
- Given the relatively high number of respondents who answered “Don’t know” to questions regarding their type of headlamp technology, headlamp optics, and headlamp beam pattern, it is likely that some of the other respondents answered these questions incorrectly. A small number of misclassifications would have the effect of diluting any differences in responses between groups (HID headlamp owners versus non-HID headlamp owners).
- In this study, no attempt was made to obtain a nationally representative sample. ACSC members may differ in some ways from other vehicle owners who are not members of an automobile club, or from those who live in different areas of the country with different weather and traffic conditions.
- The response rate for the headlamp survey was approximately 21 percent. This is a fairly high rate for a single-contact mail-out survey of this length without any type of incentives for respondents. However, the sample may not be representative of ACSC members. Future studies of this type should attempt to increase the response rate by converting non-responders to responders through methods such as a second or third mailing, through a telephone call, or by offering an incentive to participate.

Implications

- Many drivers don’t know what type of headlamps they have. This suggests that vehicle owners may need better education about the technology on their vehicles. Further research could determine if the lack of knowledge about headlamps is indicative of a more general lack of knowledge about in-vehicle technologies.
- Among older respondents, the effects of light from oncoming vehicles depended significantly on whether or not the respondents had HID headlamps. Older respondents with HID headlamps were more likely to find light from oncoming vehicles acceptable as compared to older respondents without HID headlamps. Further objective research is needed to determine if and how HID headlamps may be beneficial for improving visibility for older drivers. For example, perhaps HID headlamps simply provide better visibility as the driver recovers from the effects of glare from oncoming vehicles, or perhaps the higher state of light adaptation (or adaptation to shorter wavelengths) induced by driving with brighter, bluer HID headlamps has a protective effect against the glare from other vehicles.
- Checking and adjusting headlamp aim may be especially important for HID headlamp owners who have 30,000 (or more) miles on their vehicles. While driving with low beams on, this group of respondents had the highest probability of receiving high-beam flashes from other drivers, which could indicate that the respondents’ low-beam

headlamps are causing excessive glare to oncoming drivers because they are misaligned, or the beam pattern of some HID headlamps may be too glaring even when aimed properly. If it is determined that the primary problem is misalignment, then drivers should be encouraged to have the aim of their headlamps checked periodically.

- A large minority (40%) of drivers said they are more willing to drive at night with HID headlamps than with conventional headlamps, and nearly a quarter of both older and younger respondents with HID headlamps said they are willing to drive faster with their headlamps as compared to conventional headlamps. Further objective research should be undertaken to understand in more detail how drivers modify their behavior as a result of having advanced headlamps.

PROJECT OVERVIEW: USE OF ADVANCED IN-VEHICLE TECHNOLOGY BY YOUNG AND OLDER EARLY ADOPTERS

This report describes survey research conducted with owners of high-intensity discharge (HID) and conventional halogen headlamp systems. It is one of a series of reports that describe the work conducted under the overall project on the use of advanced in-vehicle technology by young and older early adopters.

Project Partners

This project was a collaborative effort between the National Highway Traffic Safety Administration (NHTSA) and AAA Foundation for Traffic Safety (AAAFTS). AAAFTS teamed up with the Automobile Club of Southern California (ACSC) to administer mail-out surveys to people who were likely to own vehicles equipped with specific, advanced, in-vehicle technologies. NHTSA engaged Westat, Inc., to work with AAAFTS and ACSC to reduce the data from returned questionnaires, and perform statistical analyses of the results.

Purpose

The purpose of the project was to assess drivers' experiences with recently introduced in-vehicle technologies. Safety issues (either positive or negative) may be discovered or better understood from the experiences of early adopters before the technologies become widely deployed in the U.S. vehicle fleet. Some specific areas of interest included drivers' acceptance of the systems, perceived effectiveness and usability of the systems, and behavioral adaptations which may occur with system use. Another area of particular interest was the use of advanced in-vehicle technologies by older drivers. For the purposes of this study, drivers 65 or older are referred to as "older drivers," and drivers younger than 65 are referred to as "younger drivers."

Specific objectives were to:

- Determine driver acceptance and behavioral adaptation to advanced technology currently available in production automobiles;
- Determine how the use of the technology has affected the driving task from a safety point of view;
- Determine how acceptance and use of technology is influenced by system interface characteristics, operation, and performance;
- Assess drivers' ability to learn how to use the technology and integrate it into the driving task;
- Compare drivers' reactions to and understanding of different interface designs; and
- Identify future research needs.

The overarching goal was to learn more about the extent to which advanced in-vehicle technologies enhance or detract from safety, particularly with respect to the capabilities and limitations of older drivers. It's possible that new technologies can assist older drivers to drive more safely with less stress, thus extending their safe driving years. It's also possible that, for some drivers, new in-vehicle technologies are misunderstood and misused in dangerous ways.

A major focus of the data analysis was to compare the responses of older drivers (65 or older) to those of younger drivers (less than 65 years old).

Project Scope

The project partners selected five in-vehicle technologies for investigation. Some of the factors considered in the choice of technologies were the research priorities of NHTSA and AAAFTS, the relative numbers of vehicle owners in the ACSC insurance database who could be expected to have each technology, and the potential to explore human factors and safety issues associated with each technology through survey methods. Five separate surveys were developed to cover:

- Backing aid systems (sensor-based systems);
- Rear-view video camera systems;
- High-intensity discharge (HID) headlamps, and directionally adaptive headlamps;
- Navigation systems; and
- Adaptive cruise control.

A total of 40,000 questionnaires were mailed to ACSC-insured members who were invited to participate based on the known manufacturer, model, and model year of their vehicles and the likelihood that the vehicles would have one of the five specific in-vehicle technologies. The number of questionnaires mailed for each technology type is shown below:

Backing Aid Systems	5,000
Rear-View Camera	5,000
Advanced Headlamp Systems	10,000
Navigation Systems	10,000
<u>Adaptive Cruise Control</u>	<u>10,000</u>
Total questionnaires mailed	40,000

The results of these five surveys will be released in a series of reports covering the different in-vehicle technologies investigated. This report describes the results from the surveys on headlamp systems.

HID HEADLAMPS, ADAPTIVE HEADLAMPS, AND GLARE

The safety and behavioral impacts of advanced headlamp systems are not known. For older drivers in particular, these technologies may improve safety by providing better visibility and may potentially increase nighttime mobility, since many older drivers limit their driving to the daylight hours due to vision concerns. On the other hand, new technologies that seem to make the driving task easier and safer may have unintended consequences that reduce the net safety benefit. If drivers with brighter headlamps can see the roadway better, they may compensate by driving faster, or by driving under riskier conditions. Older drivers who believe that they can see better with bright headlamps may increase their crash risk by driving more often or by shifting some of their trips from daytime to riskier nighttime hours. Headlamp glare caused by brighter headlamps is also a safety concern for younger and older drivers.

Functional Characteristics of High-Intensity Discharge (HID) Headlamp Systems and Adaptive Headlamp Systems

Much of the information given in this section was taken from an inventory of in-vehicle devices that was conducted as part of the current project and previous projects (Llaneras & Singer, 2002; Llaneras, Neurauter, Singer, & Jenness, 2005).

High-intensity discharge (HID) headlamps

In 2003, approximately 1 million new vehicles in the U.S. were sold with HID headlamps (Motor Vehicle Lighting Council, n.d.) The light source in a high-intensity discharge HID headlamp is a high-voltage electrical arc rather than a tungsten filament as in conventional halogen headlamps. This results in the lamp having a brighter, more bluish-white appearance. In fact, high-intensity discharge (HID) headlamps may provide approximately twice as much light (luminous flux) as conventional tungsten-halogen headlamps (Sivak, Flannagan, Schoettle, & Nakata, 2002). Measurements of average beam patterns show that as compared to conventional headlamps, HID headlamps tend to provide greater luminance intensity in all parts of the beam except for a narrow central cone near the horizon and an area above the horizon in the far left periphery (Sivak, et al., 2002). From the driver's perspective, this results in a wider area of low-beam illumination below the horizon.

The beam pattern from HID headlamps may be formed by projector optics or by reflector optics. In either case, HID headlamp optics may produce a beam pattern with sharp edges between light and dark areas. While in motion over undulating roads, a sharp cut-off beam pattern may cause headlamps to appear to flicker or flash to other drivers. Conventional (tungsten-halogen) headlamps also may use either projector optics or reflector optics and may have a sharp cut-off beam pattern or a fuzzier, less distinct beam pattern.

For the purposes of this study, the term, "HID headlamps" is used to refer to systems where high-intensity discharge light sources are used only for the low beam as well as for systems where the HID sources are used for both high beams and low beams.

Adaptive headlamps

Vehicles equipped with adaptive headlights are capable of adjusting the aim of the headlight beams to illuminate the roadway based on inputs from the vehicle's steering wheel, speed,

and/or yaw. There are currently seven manufacturers (vehicle makes) offering vehicles equipped with adaptive headlight technology. Only four vehicle models include adaptive headlights as standard equipment. These include the Acura RL (2005), BMW 6-Series (2005; includes 645Ci coupe and convertible), BMW 7-Series (2006; includes 750i, 750Li, 760i, and 760Li), and Lexus LS430 (2005). However, several other models offer trim levels that include adaptive headlights as a standard feature, including Audi's A6 & A8, BMW's 3-Series, 5-Series, and X5, Infiniti's M35/45, Range Rover, and the Lexus GS & RX. In general, the technology for adaptive headlights is still reserved for higher-end luxury vehicles, although some of the entry-level models within luxury brands are beginning to come equipped (Audi A4, BMW 3-Series, etc.) Depending on the manufacturer, these systems are marketed under a variety of product names, but all include some variation of "adaptive" or "active" with "headlights" or "light system." Regardless of the manufacturer, all the systems serve primarily the same purpose, which is to illuminate the intended path of travel by pivoting the headlamps in connection with dynamic variables.

Each manufacturer has its own individual logic and features with respect to adaptive headlights. For example, the degree of pivoting varies by manufacturer. Acura's RL has headlights that can pivot up to 20 degrees, whereas the system offered by Lexus across its line has maximum pivot angles for the driver and passenger headlights of 15 and 5 degrees respectively. Additionally, some manufacturers choose to pivot both headlights, while others pivot the inside headlight only (i.e., driver's side on a left-hand turn). Some systems won't operate until a certain speed is attained (16 mph for Infiniti, 18 mph for Lexus), and may cut off when the speed falls below a threshold (3 mph for Lexus).

Headlamp Glare

Glare refers to the sensory effects caused by a bright light in one's field of view (glare source). Researchers have made a distinction between the uncomfortable feelings (or pain) caused by the glare source (discomfort glare) and the reduction in visibility caused by the glare source (disability glare). Both aspects of glare may impair driving performance. For example, discomfort glare may cause drivers to look away from an oncoming vehicle and the forward roadway, slow down, or drift in their lane. Disability glare can reduce the driver's ability to react to potential hazards both by masking the view of the hazard with veiling light scattered within the eye, and by decreasing visual sensitivity for a period of time even after the glare source is no longer present.

Summaries of headlamp glare and associated driving performance issues are available in a recent report to Congress (NHTSA, 2007) and through an AAAFTS report on the topic (Mace, Garvey, Porter, Schwab, & Adrian, 2001). Glare from headlamps of oncoming vehicles and from following vehicles has been a safety concern for many years, but the problem has taken on more urgency with recent changes in headlamp technology from sealed beam and halogen filament-based light sources to HID sources, (and soon to state-of-the-art headlamps with light-emitting diodes (LED) as the light source). A public comment docket on headlamp glare (Docket No. 01-8885) has received more than 5,700 comments since it was opened in 2001, and contains many complaints about the glare produced by HID headlamps or other types of forward lighting. NHTSA has been undertaking research to discover the causes of these complaints.

A recent NHTSA-sponsored survey of headlamp aim in New York State found that two-thirds of passenger cars measured had at least one headlamp improperly aimed (Lighting Research Center, Rensselaer Polytechnic Institute, 2005). A headlamp misalignment can reduce the driver's ability to see down the roadway and it can increase the glare for other drivers. Because HID headlamps have more light output in certain directions than conventional (halogen) headlamps, slight misalignments of HID headlamps may produce more severe glare than the same amount of misalignment with conventional headlamps.

In the present survey respondents with HID headlamps and respondents with conventional headlamps were asked whether they have had the aim of their headlamps checked. Also they were asked how often they receive high-beam flashed from other drivers, which usually indicates that the other driver is experiencing so much glare that he or she believes that the oncoming vehicle's high beams are on. If HID headlamps tend to produce more glare than conventional headlamps, respondents with HID headlamps may experience more high-beam flashes from other drivers. All respondents were also asked about their experience with light coming from other vehicles. It is possible that on average drivers who have HID headlamps may be adapted to higher light levels than drivers with conventional headlamps, and therefore may not be bothered as much by headlamp glare from oncoming vehicles.

Glare may be more of a problem for older drivers as compared to younger drivers. As the visual system ages, changes in the cornea, lens, and other optical media of the eye cause more light to be scattered, producing a veil of brightness within the eye. This has the effect of reducing the driver's contrast sensitivity. As the driver ages, the maximum pupil size decreases and the lens becomes less transparent, reducing the amount of light that reaches the retina. Therefore, older drivers can have more trouble seeing at night. Due to the increased tendency for light to scatter within the eye, and the reduced amount of light available to form an image on the retina, the disabling effects of glare may be more severe for older drivers.

Neurological changes in older adulthood also may exacerbate the effects of glare. Older drivers generally require more time to recover visual sensitivity following exposure to a bright light as compared to younger drivers. In the present study the older and younger drivers' responses were compared on questions related to glare and drivers' responses to light from other vehicles.

DEVELOPMENT OF SURVEYS

Content areas

Questionnaires were developed through an iterative process that included several stages of review by project partners. Initial drafts of the questionnaires were based on NHTSA’s exploratory study of early adopters of in-vehicle technologies (Llaneras, 2006). Many new items were written to address the specific objectives of the current project such as determining driver acceptance and adaptation to the technologies and determining how use of the technology has affected safety of the driving task. Items were developed to address several key content areas, including:

- Background information about the vehicle owner – age, gender, experience with the vehicle, etc.;
- Desire to have the technology;
- Learning how to use the technology – sources of information, difficulty with learning;
- Behavioral adaptation to the technology – changes in driving behavior with the technology, how drivers rely on the technology;
- Perceived effectiveness of the technology – how well owners believe that the technology works under several specific scenarios and weather conditions;
- User interface and usability – sounds, visual displays;
- Safety – overall opinion of the safety of the system, driving incidents related to the technology; and
- Need for improvements – owners’ suggestions for needed improvements regarding the technology and regarding the design of vehicles for older people.

All of the questionnaire items are listed in Table 1. Items are grouped by their key topic area. Note that some items may apply to more than one topic area, but they are listed here only under their primary topic area.

Table 1. Headlamp systems questionnaire: Content areas and associated items

Background and Knowledge about Headlamps	1. Age 2. Gender 3. Which of the following statements describe your vision? 4. Approximately how many miles have you personally driven this vehicle? 5. Did you test-drive the vehicle at night prior to purchasing it? 14. Is your low-beam headlight small and round, with an opaque lens (that you can’t see though) similar to the one shown by the arrow? 15. Which photo looks more like the light pattern your headlights would project on a wall? 16. High-Intensity Discharge (HID) (sometimes called Xenon headlights)-HID headlights appear slightly bluish-white as compared to the yellowish-white light of conventional Halogen headlights. Does your vehicle have HID or Xenon headlights? 16B. If no, then why didn’t you choose to get a vehicle with HID headlights? 18. Adaptive (or “active”) headlights can automatically change the direction of the light beam when you steer left or right on curved roads. On your vehicle, these headlights may be called “steerable headlights” or something similar. Does your vehicle have adaptive (or “active”) headlights? 18B. If no, then why didn’t you choose to get a vehicle with adaptive headlights?
Acceptance	17. If you purchased this same model vehicle again, would you want HID headlights? 19. If you purchased this same model vehicle again, would you want adaptive headlights? 22E. I prefer my headlights to conventional headlights

Behavioral Adaptation to System	<p>6. Have you ever had the aim of your headlights checked or adjusted on this vehicle? 6B. If yes, why?</p> <p>7. During the winter months, how often do you drive when it is dark outside?</p> <p>21. If your headlight system had to be replaced with conventional headlights, how would your driving behavior change?</p> <p>22A. I use the high beams less often than I would if I had conventional headlights (strongly disagree, disagree, neutral, agree, strongly agree)</p> <p>22C. I am more willing to drive at night with my headlights than with conventional headlights (strongly disagree, disagree, neutral, agree, strongly agree)</p> <p>22D. I am more willing to drive faster using my headlights' low beams than with the low beams from conventional headlights (strongly disagree, disagree, neutral, agree, strongly agree)</p>
Perceived Effectiveness	<p>9. How easy is it for you to see each of the following while driving at night?</p> <p>9A. On curved roads, how easy is it for you to see lane lines using your low beams?</p> <p>9B. How easy is it for you to read overhead road signs that are not lighted except by your headlights' low beams?</p> <p>9C. On roads without street lights, how easy is it for you to see pedestrians on or near the road using your low beams?</p> <p>9D. When you approach a hill how easy is it for you to see the roadway up the hill ahead using your low beams?</p> <p>22B. I feel less eye strain driving at night with my headlights than with conventional headlights (strongly disagree, disagree, neutral, agree, strongly agree)</p>
Safety and Headlamp Glare	<p>8. When you drive at night, how often do other drivers flash their high beams at you even though you have your low beams on?</p> <p>10. In the last six months, while driving at night, the light from oncoming vehicles generally has been: (Blinding/Disturbing, Annoying, Acceptable).</p> <p>11. In the last six months, the light from oncoming vehicles has caused me to: (Block the light with my hands, Look to the right side of the roadway, away from the roadway directly ahead, Slow down or stop until the oncoming light has passed, Unintentionally drive off the edge of the road, Have a crash or close call, Limit the amount of driving that I do at night, avoid driving on unlighted two-lane roads, None of the above)</p> <p>12. In the last six months, while driving at night, the light from vehicles behind me generally has been: (Blinding/Disturbing, Annoying, Acceptable)</p> <p>13. In the last six months, while driving at night, the light from oncoming vehicles behind me has caused me to: (Block the light with my hands, Move my head or eyes away from the light reflected from my mirrors, Turn the inside rear-view mirror to the "dim" position, or move the mirror itself, Slow down or stop until the vehicle has passed, or turned off the road, Unintentionally drive off the edge of the road, Have a crash or close call, Limit the amount of driving that I do at night, None of the above)</p> <p>23. Overall, do your HID and/ or adaptive headlights make you a safer driver than if you had conventional headlights?</p>
Need for Improvements	<p>20. Is there anything about your headlights that you think should be improved?</p> <p>20A. If yes, please explain.</p> <p>24. In general, do you believe that car manufacturers are doing enough to design vehicles to accommodate an aging population?</p> <p>24A. If you answered "no" then what more do you believe could be done?</p>

The questionnaire was designed so that all survey items and a cover letter could be printed (double-sided) on no more than five sheets of paper. Restricting the questionnaire packet to only five printed pages allowed it to be folded into thirds and mailed out in standard business-size envelopes. Another reason for restricting the size of the questionnaire was to ensure that as many people as possible would be willing to spend the time required to fill it out. Pilot tests were conducted to ensure that the typical completion time for each questionnaire was less than 15 minutes. (The headlamp questionnaire is included in Appendix A.)

Questionnaires for the headlamp survey were mailed out during November, 2006. A cover letter from ACSC was included that explained the purpose of the survey and invited the vehicle owner to participate (see Appendix A). All vehicle owners who received questionnaires were asked to return the questionnaire even if they did not have the indicated technology on their vehicle. On the back of the cover letter, respondents were asked whether they would be willing to participate with ACSC in a brief phone interview about their vehicles. Those who were willing to do this were asked to write in their contact information.

Telephone Interviews

A subset of survey respondents who gave their consent to be called was selected for follow-up telephone interviews. ACSC staff only called system owners who indicated on the written questionnaire that they thought that their headlamp system should be improved, as a goal of the telephone interviews was to uncover any potential problems with the systems that were not addressed by items on the questionnaire. ACSC staff made up to three attempts to contact each member selected for a phone interview. The telephone interviewers used a script to guide the conversation (see Appendix C). Thirty-four people were interviewed. The interviewees' comments are given in Appendix D. Selected comments from the telephone interviews also are included (*in italics*) in the Results section.

Sampling

The sampling plan and data collection protocol for this study were designed to meet the mutual needs of all project partners. Practical considerations, such as project budgets, amount of data available in the ACSC insurance database, and estimated questionnaire return rate contributed to the sampling plan. ACSC queried their database to identify a subset of customers who owned particular vehicle models (and model years) that have HID headlamps or adaptive headlamps as standard or optional equipment. It is important to note that the resulting list of vehicle owners represents possible (but not certain) owners of advanced headlamps. Based on ACSC records, there was no way to know if the vehicle owner had actually purchased optional equipment.

Headlamp questionnaires (n = 10,000) were mailed to a random sample of these candidate system owners subject to the following constraints. To the extent feasible, 75 percent of the questionnaires for each survey were mailed to vehicle owners whose vehicles included the headlamp technology as a factory-installed standard feature and 25 percent of the questionnaires were mailed to owners of vehicles on which the technology was a factory-installed optional feature. In practice, after the survey had been administered it was discovered that a small number of questionnaires were mailed to owners of vehicle models/model years on which advance headlamp technology was not available. This is described further in the results section below.

An additional sampling requirement was that, to the extent possible, one-half of the questionnaires were mailed to vehicle owners 65 or older, and the other half were mailed to vehicle owners who were 25 to 64 years old. Respondents were not offered any monetary or other incentives for their voluntary participation.

RESULTS

Tabulated response frequencies for all survey items are shown in Appendix B. For most items the response frequencies for those who have HID headlamps are shown in addition to the overall response frequencies from all respondents. A key goal of the analysis effort described in this section was to compare responses from vehicle owners who have advanced headlamp technology to responses from vehicle owners who do not have these technologies. Although this survey was concerned with both HID headlamps and directionally adaptive headlamps, the sample of respondents with adaptive headlamps was too small for most statistical analyses. Ninety-nine respondents reported having adaptive headlamps, but subsequent analysis of the vehicle makes, models, and model years of these 99 respondents' vehicles said only 13 of them were likely to have adaptive headlamps as original standard equipment or as an available option on their particular vehicle model and model year. Confusion over headlamp technology in general and adaptive headlamps in particular, is understandable because there are several other recently-introduced forward lighting features with names that may be mistaken for directionally adaptive headlamps. Some of these other features are, "manually adjustable headlights," "self-leveling headlights," "programmable headlights," and "cornering lights" (separate lights activated only with the turn signals). None of these systems was studied in this survey.

In the sections below the results from the mail-out headlamp survey are discussed by topic area. Selected comments from respondents who were contacted for telephone follow-up interviews have been inserted where appropriate. The entire set of comments from the telephone interviews is given in Appendix D.

1. Response Rate

Vehicle owners selected for the headlamp survey were instructed to return the questionnaire even if they did not have HID headlamps or adaptive headlamps on their vehicle. Of the 10,000 questionnaires mailed out, 2,126 were returned (21.3%).

2. Classification of Responses by Type of Headlamps

Two sources of information were used to determine whether respondents' had HID headlamps. The first was self-report data from questionnaire item Q16 ("Does your vehicle have HID or Xenon headlights?"), and the second was ACSC information about the respondent's vehicle manufacturer, model year, and ACSC vehicle model code. HID headlamp availability may be determined by researching information about what original equipment was available on each vehicle model and model year; however, in practice this system of classification was not entirely reliable because ACSC model codes sometimes refer to more than one similar model or to more than one trim level and HID headlamp status (not available, available option, standard equipment) often varies with trim level.

Table 2 shows the response frequencies for item Q16 broken out by HID availability as determined by researchers based on the respondent's vehicle model and model year. Among the respondents whose vehicles came with HID headlamps as standard equipment (cells A, B, C), approximately 13 percent (cell B) seem to have answered Q16 incorrectly by saying that they did not have HID headlamps. Similarly, incorrect responses were given by 13 percent of the

respondents who said they had HID headlights despite the fact that their vehicles did not have HID headlights available as an option at the time of purchase (cell G). The proportion of older respondents who gave an incorrect response to item Q16 (i.e. cells B and G) was not significantly different from the proportion of younger respondents who gave an incorrect response, $\chi^2(1) = 0.5, p = .49$. Among those whose vehicle models had HID headlamps available as an option (cells D, E, F), it was not possible to determine whether the respondents were correct or incorrect in their responses to item Q16.

Table 2. Reported HID headlamp status (Q16) by HID availability on vehicle model

Cell Frequency (Col. Pct.)	HID standard	HID optional	HID not available	Total
Yes	A 750 (71.98)	D 367 (38.55)	G 9 (13.24)	1,126 (54.61)
No	B 138 (13.24)	E 388 (40.76)	H 46 (67.65)	572 (27.74)
Don't know	C 154 (14.78)	F 197 (20.69)	I 13 (19.12)	364 (17.65)
Total	1,042	952	68	2,062
Row Pct.	50.53	46.17	3.30	100.00

From all of the respondents represented in Table 2, two groups were selected to be used in all subsequent analyses that compared responses from those with HID headlamps to responses from those without HID headlamps. The HID headlamp group included respondents whose answer to item Q16 said they had HID headlamps. However, this group included only respondents whose vehicles had HID headlamps as a standard feature (cell A) and those whose vehicles had HID headlamps as an available option (cell D). Respondents who reported having HID headlamps but had vehicles on which HID headlamps were not available (cell G) were excluded. A comparison group of respondents who did not have HID was created with respondents who said they did not have HID headlamps (Q16). Respondents were excluded from this group if ACSC data said their vehicle models were among those with HID headlamps as a standard feature (cell B). Based on this classification procedure, 1117 respondents were in the HID headlamp group and 434 respondents were in the non-HID headlamp group. Due to the uncertainty regarding HID availability, respondents who said they did not know whether they had HID headlamps (cells C, F, I) were not included in comparisons between HID and non-HID headlamp owners.

A similar procedure was used to classify respondents with respect to adaptive headlamps, but, as mentioned above, this resulted in a sample of only 13 respondents with adaptive headlamps.

When interpreting comparisons between responses from owners of HID headlamps and non-HID headlamps, it is important to keep in mind that:

- The classification of HID headlamp owners versus non-HID headlamp owners was based primarily on self reports of those who said either that they have HID headlamps or that they do not have HID headlamps. A large number of survey respondents (18%) said they did not know whether they had HID headlamps on their vehicle or not. Approximately 13 percent of respondents who did not have HID headlamps available on their vehicle model incorrectly thought that they did have them.
- The age distribution for respondents who reported having HID headlamps is different from those who reported not having HID headlamps, $\chi^2(5) = 175.0, p < .001$ (also compare Figure 2 and Figure 3). Respondents with HID headlamp were generally younger than those who do not have HID headlamps.
- Differences in gender between HID headlamp owners and non-HID headlamp owners did not reach statistical significance, $\chi^2(1) = 2.7, p = .10$, and respondents' level of experience with their vehicles (miles driven) also did not differ significantly between HID headlamp owners and non-owners, $\chi^2(4) = 5.5, p = .24$.
- HID headlamps are not all the same with regard to optics and beam patterns. Likewise, not all non-HID headlamps are the same.

3. General Characteristics of Survey Respondents

Age and gender

Figure 1 shows the number of respondents in each of six age categories who reported their age on the survey. Figure 2 shows the similar age and gender distribution for those who have HID headlamps and Figure 3 shows the distribution for those who do not have HID headlamps. In all three figures the dark bars represent the number of men and the lighter bars represent the number of women. Overall, the male respondents tended to be older (median = 65 years) than the female respondents (median = 56 years). The proportion of female respondents in each age group decreased with age from 49 percent of those less than 35 years old to 30 percent of those who are 75 or older.

Approximately 32 percent of the respondents who own HID headlamps were women. Among those who have HID headlamps, the proportion of female respondents decreased with age from 42 percent of those less than 35 years old to 26 percent of those who are 75 or older.

In every age group, men were more likely than women to report having HID headlamps. It is possible that women were more likely than men to own HID headlamps without knowing it. Women (22.5%) were significantly more likely than men (14.5%) to answer that they “don’t know” whether or not they have HID headlamps on their vehicles ($z = 4.34, p < .001$).

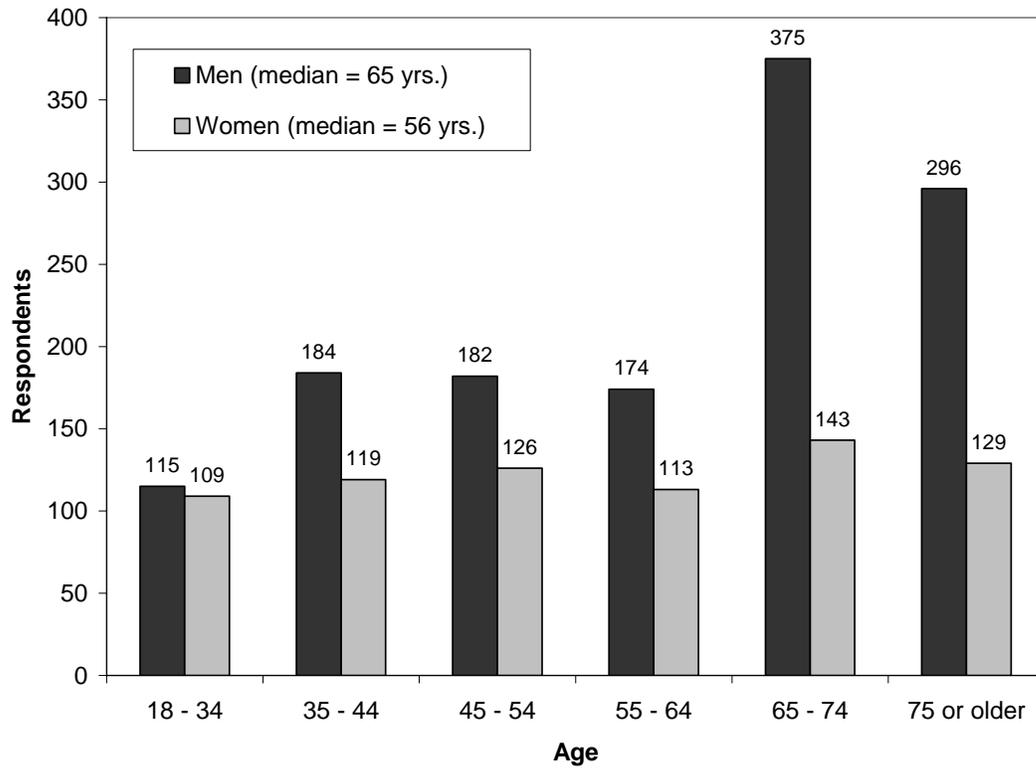


Figure 1. Age and gender of all respondents to the headlamp survey

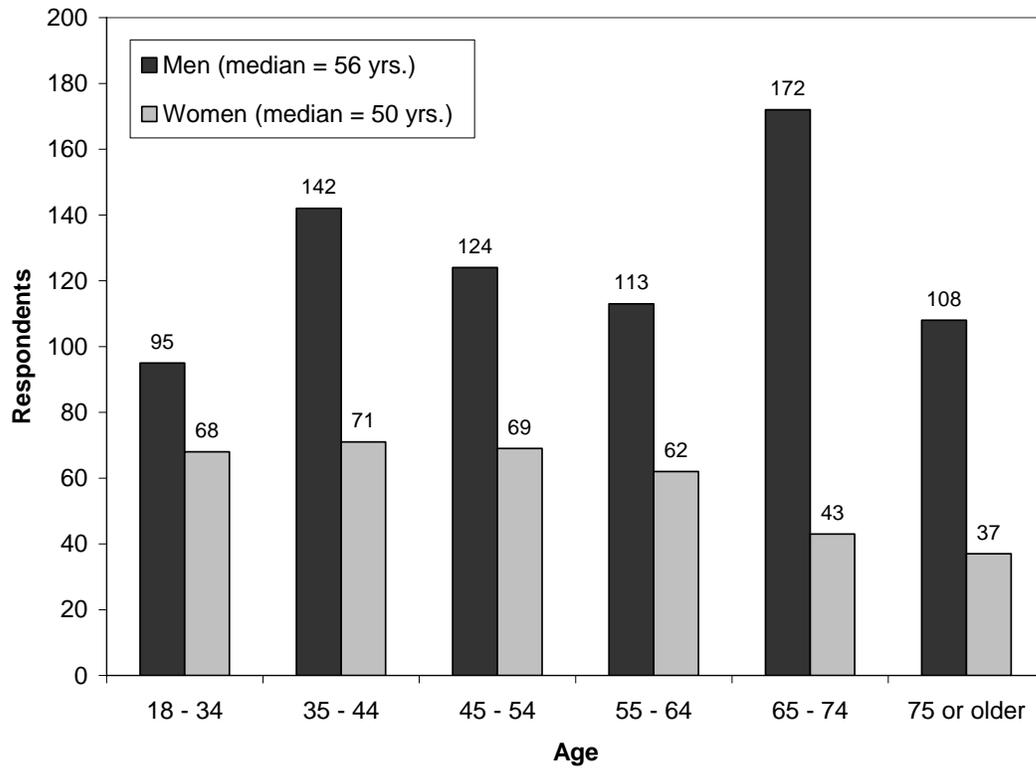


Figure 2. Age and gender of respondents who have HID headlamps

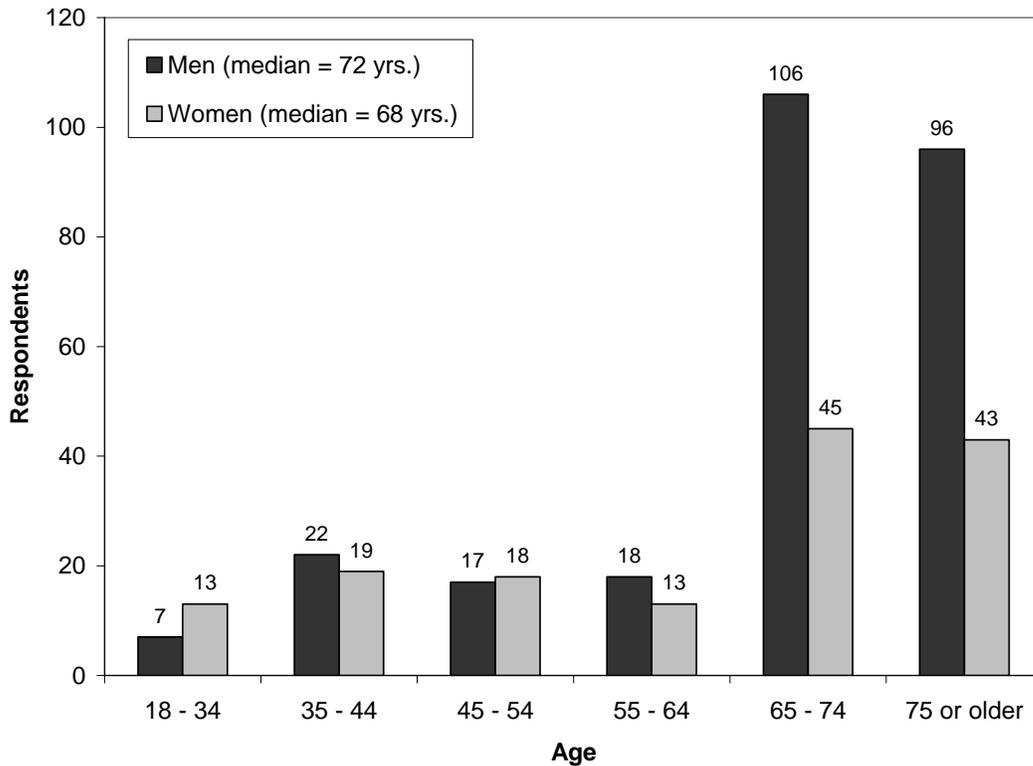


Figure 3. Age and gender of respondents who do not have HID headlamps

The numbers of younger and older respondents with HID headlamps on vehicles manufactured by each of the six most common manufacturers in the sample are shown below in Table 3. It is clear from this table that the distribution of respondents across the two age groups differs significantly by manufacturer, $\chi^2(5) = 53.8, p < .001$. Audi owners had the smallest proportion of older respondents (26.8%) and Toyota owners had the greatest proportion of older respondents (57.1%). When interpreting differences in survey responses between respondents who have different vehicle manufacturers, age differences between the groups should be considered.

Table 3. Age group and vehicle manufacturer for respondents with HID headlamps

Frequency (Col. Pct.)	Acura	Audi	BMW	Mercedes-Benz	Nissan	Toyota	Total
Younger than 65	344 (73.19)	39 (84.78)	52 (44.44)	21 (55.26)	178 (68.73)	15 (42.86)	649 (67.25)
65 or older	126 (26.81)	7 (15.22)	65 (55.56)	17 (44.74)	81 (31.27)	20 (57.14)	316 (32.75)
Total	470	46	117	38	259	35	965
Row Pct.	48.70	4.77	12.12	3.94	26.84	3.63	100.00

Vision conditions that may make driving at night more difficult

“The HID lights are especially helpful when you have a little night blindness like I have, you can see much better.” (Male, 39)

Respondents were asked, (Q3): “Which of the following statements describes your vision?” In general, older respondents reported more vision conditions than younger respondents. Table 4 shows the percentage of younger and older respondents who reported each of the vision conditions listed. Older respondents were significantly more likely to report wearing glasses while driving at night, $\chi^2(1) = 131.9, p < .001$, having cataract surgery, $\chi^2(1) = 238.9, p < .001$, currently having cataracts, $\chi^2(1) = 44.0, p < .001$, or having another vision condition $\chi^2(1) = 14.1, p < .001$. Younger respondents were more likely to report wearing contact lenses while driving at night, $\chi^2(1) = 94.5, p < .001$; having Lasik surgery, $\chi^2(1) = 37.0, p < .001$; or having none of the vision conditions listed, $\chi^2(1) = 14.1, p < .001$.

- Consistent with the observed age difference between headlamp groups (HID headlamp owners are generally younger), respondents who have HID headlamps were more likely than those with HID headlamps to report wearing contact lenses while driving at night, $\chi^2(1) = 13.4, p < .001$, having Lasik surgery, $\chi^2(1) = 6.3, p < .05$, and having “none of the above” vision conditions $\chi^2(1) = 8.6, p < .01$. Those without HID headlamps were significantly more likely to report wearing glasses when driving at night, $\chi^2(1) = 9.0, p < .01$, having cataract surgery, $\chi^2(1) = 26.6, p < .001$, or having another vision condition $\chi^2(1) = 10.1, p < .01$.

Table 4. Vision conditions by age group (Q3)

Percentage of respondents who reported having each vision condition	Younger than 65 (n = 1151)	65 or Older (n = 948)	All Respondents (n = 2099)
I wear glasses when driving at night	39.27	64.45	50.64
I wear contact lenses when driving at night	16.85	3.59	10.86
I had Lasik surgery	10.25	3.38	7.15
I had cataract surgery	0.96	24.68	11.67
I currently have cataracts	0.43	4.96	2.48
I have another vision condition	2.35	5.49	3.75
None of the above	37.97	18.14	29.01

Respondents' vehicles

Counts of respondents' vehicle manufacturers and model years are shown in Appendix B. Respondents owned vehicles from 19 different vehicle manufacturers (makes), although most (86%) had vehicles from only six manufacturers (Acura, BMW, Cadillac, Mercedes-Benz, Nissan, and Toyota). Due to the small sample size obtained for other vehicle manufacturers, specific comparisons between vehicle manufacturers were restricted to these six manufacturers. Most vehicles were from the 2001 to 2005 model years with an additional 13 vehicles from the 2006 model year.

Driving experience with current vehicle

On the headlamp questionnaire vehicle owners were asked to write-in the number of miles they had driven their vehicles. This item (Q4) was used as a surrogate measure of experience with the vehicle and its associated headlamp technology. For analysis purposes, responses were grouped in mileage (experience) categories. Among all respondents to the headlamp survey, experience was not significantly related to gender, $\chi^2(4) = 6.6, p = .16$, but it was significantly related to age group, $\chi^2(4) = 38.8, p < .001$. As shown in Table 5 older respondents (median = 20,000 miles) tended to have less experience driving their current vehicles as compared to younger respondents (median = 25,000 miles). Among respondents who have HID headlamps, experience also depended significantly on age group, $\chi^2(4) = 32.2, p < .001$. The experience levels of respondents with HID headlamps are shown by age group in Table 6.

Table 5. All respondents by age and by experience with their vehicles

Frequency Row Pct. (Col. Pct.)	Less than 5,000 Miles	5,000 to 9,999 Miles	10,000 to 19,999 Miles	20,000 to 29,999 Miles	30,000 or More Miles	Total
Younger than 65	64 5.69 (42.67)	94 8.36 (46.08)	241 21.44 (51.06)	240 21.35 (56.74)	485 43.15 (62.99)	1,124 (55.67)
65 or Older	86 9.61 (57.33)	110 12.29 (53.92)	231 25.81 (48.94)	183 20.45 (43.26)	285 31.84 (37.01)	895 (44.33)
Total	150 7.43	204 10.10	472 23.38	423 20.95	770 38.14	2,019 100.00

Table 6. Respondents with HID headlamps by age and by experience with their vehicles

Frequency Row Pct. (Col. Pct.)	Less than 5,000 Miles	5,000 to 9,999 Miles	10,000 to 19,999 Miles	20,000 to 29,999 Miles	30,000 or More Miles	Total
Younger than 65	30 4.07 (43.48)	71 9.63 (65.74)	166 22.52 (63.85)	148 20.08 (68.20)	322 43.69 (75.41)	737 (68.18)
65 or older	39 11.34 (56.52)	37 10.76 (34.26)	94 27.33 (36.15)	69 20.06 (31.80)	105 30.52 (24.59)	344 (31.82)
Total	69 6.38	108 9.99	260 24.05	217 20.07	427 39.50	1,081 100.00

Frequency of driving when it is dark

Item Q7 asked respondents to report how often they drive during the winter months when it is dark outside. The question asked about the winter months specifically because there are fewer hours of daylight available at that time of year. The results are shown in Figure 4 separately for older and younger respondents. The distributions differ significantly, $\chi^2(4) = 309.8$, $p < .001$. Younger respondents reported a much higher frequency of driving when it is dark outside as compared to older respondents.

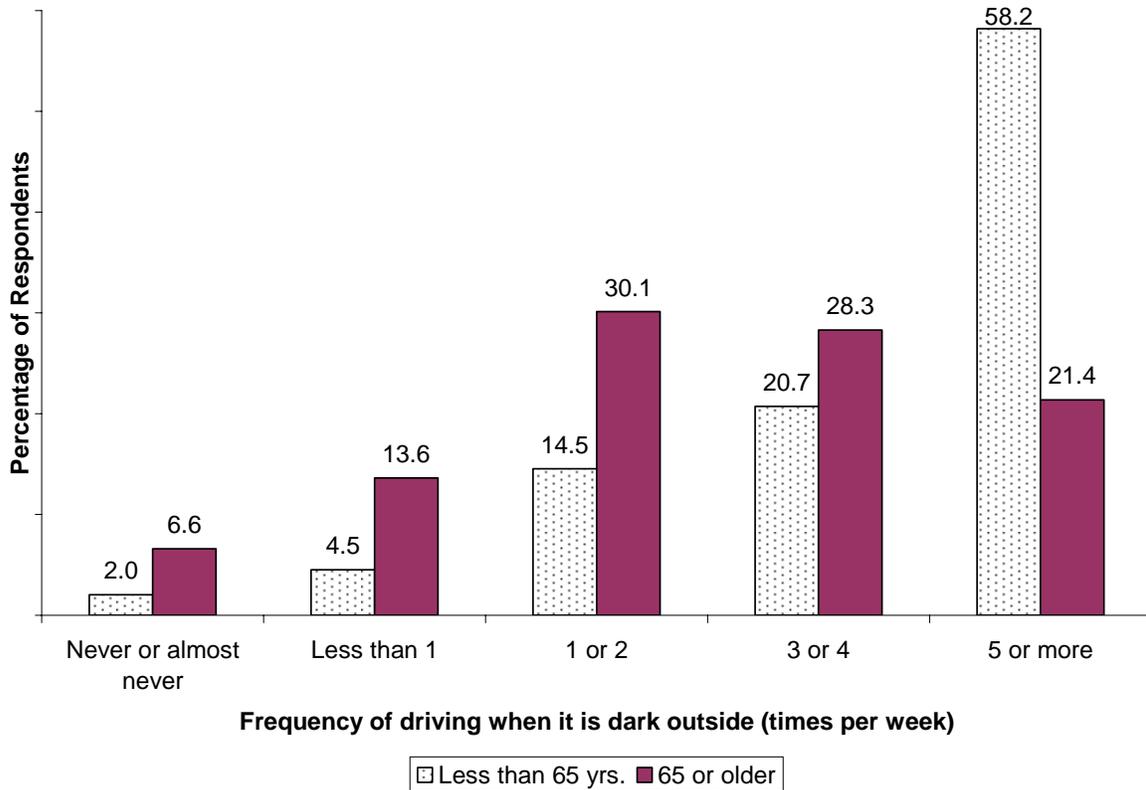


Figure 4. Frequency of driving when it is dark outside by age group

Due to the small sample sizes, further analyses of driving frequency in the dark were conducted by recoding the data to combine responses in the two lowest frequency categories (“Never . . .” and “less than one”). Using this recoded data, the frequency of driving in the dark was significantly different for those who have HID headlamps as compared to those who do not have HID headlamps, $\chi^2(3) = 21.2, p < .001$. However, this effect may be explained by the difference in the age distributions for the HID and non-HID groups (as seen in Figure 6 and Figure 7, HID headlamp owners tend to be younger) combined with the tendency for older drivers to drive much less often when it is dark as compared to younger drivers. Among younger drivers, the frequency of driving in the dark did not depend significantly on whether the respondent had HID headlamps or not, $\chi^2(3) = 1.2, p = .74$, and among older drivers the frequency of driving in the dark also did not depend significantly on whether the respondent had HID headlamps or not, $\chi^2(3) = 1.2, p = .75$.

4. Desire to Have HID Headlamps and Adaptive Headlamps

“I specifically looked for HID lights when I bought my car.” (Male, 35)

Approximately 18 percent of all respondents and 21 percent of HID headlamp owners said they test-drove their vehicles at night prior to purchasing them (Q5). The responses to this item did not differ significantly by vehicle manufacturer, $\chi^2(5) = 8.5, p = .13$.

HID headlamps

Survey respondents were asked (Q17): “If you purchased this same vehicle again would you want HID headlights?” The response frequencies for this item are shown in Table 7. It is clear from this data that respondents who currently have HID are generally satisfied with their HID lamps as the vast majority (88%) of system owners would want to purchase them again. Also, 75 percent of respondents who have HID headlamps agreed or strongly agreed with the statement, “I prefer my headlights to conventional headlights” (Q22E). Respondents who do not currently have HID headlamps are much less certain about wanting to get them, with 40 percent saying that that don’t know whether they would want to them and only 23 percent saying that they would want them.

Table 7. Respondents’ desire to have HID headlamps by current headlamp type

Frequency (Col. Pct.)	HID	No HID	Total
Yes	957 (87.88)	99 (23.29)	1,056 (69.75)
No	40 (3.67)	154 (36.24)	194 (12.81)
Don’t Know	92 (8.45)	172 (40.47)	264 (17.44)
Total Row Pct.	1,089 71.93	425 28.07	1,514 100.00

Respondents who said they do not have HID headlamps were asked why they did not choose to get a vehicle with this technology (item Q16A). The two most common reasons cited for not having HID headlamps were related to lack of knowledge about the system and/or availability of the system. Approximately 69 percent of respondents who said they do not currently have HID headlamps said, “It never occurred to me to look for one when I was buying the vehicle,” and 41 percent said, “It was not an option on my vehicle.” Nearly 17 percent of the respondents didn’t choose to get HID headlamps because they thought that they “would be a nuisance or distraction to other drivers.” Relatively few respondents cited cost (7%) or bundling with other unwanted options (4%) as a reason for not choosing to get a vehicle with HID headlamps. The complete list of response frequencies for these items is shown in the Appendix B.

Adaptive headlamps

Survey respondents were asked (Q19): “If you purchased this same vehicle again would you want adaptive headlights?” Approximately 46 percent of all respondents said they would want to get adaptive headlamps, 12 percent said they would not, and 42 percent said they didn’t know. All 12 of the respondents to item Q19 who currently have adaptive headlamps said they would want to get them again. Among those who currently have HID headlamps, 52 percent said they would want to get adaptive headlamps.

Respondents who said they do not have adaptive headlamps were asked why they didn’t choose to buy vehicles with this technology (item Q18A). The most common reason cited for

not having adaptive headlamps was related to lack of system availability. Approximately 70 percent said, “It was not an option on my vehicle.” Approximately 42 percent of respondents who said they do not currently have HID headlamps said, “It never occurred to me to look for one when I was buying the vehicle.” Less than 3 percent of the respondents to this question cited the cost or any of the other possible responses as reasons why they didn’t choose to get adaptive headlamps.

5. Uncertainty Regarding Headlamp Type and Beam Pattern

A large percentage of respondents (18%) reported they did not know whether they had HID headlamps or not (Q16) and nearly 20 percent reported not knowing whether they had adaptive headlamps (Q18). Knowledge of headlamp type depended on gender and age category.

- Women (23%) were more likely than men (15%) to say they didn’t know whether they had HID headlamps on their vehicles, $z = 4.35, p < .001$.
- A significantly greater percentage of older respondents (21%) as compared to younger respondents (15%) didn’t know whether they had HID headlamps on their vehicles, $z = 3.89, p < .001$.

Two survey items were designed to determine if the participants’ headlamps used projector optics (Q14) and whether they had sharp cut-off beam patterns (Q15). Participants were instructed to, “Please look at your vehicle’s headlights to answer the following two questions.”

- Q14 - Is your low beam headlight small and round, with an opaque lens (that you can’t see through) similar to the one shown by the arrow?
- Q15 - Which photo below looks more like the light pattern your headlights would project on a wall?

Approximately 24 percent of all respondents said they did not know the answer to item Q14, and nearly 31 percent did not know the answer to item Q15. Even among those who knew whether they had HID headlamps, many respondents didn’t know about their headlamp lens type (19%) or headlamp beam pattern (26%). Table 8 shows the responses to item Q14 for respondents who have HID headlamps and those that do not have HID headlamps. Those without HID headlamps were more likely to say they didn’t know as compared to those with HID headlamps, $z = 2.55, p < .05$. Similar results were found for item Q15 regarding beam pattern (Table 9). Respondents without HID headlamps were more likely than respondents with HID headlamps to say that they didn’t know which type of beam pattern their headlamps projected, $z = 4.06, p < .001$.

Table 8. Apparent lens type for HID headlamps and non-HID headlamps (Q14)

Frequency (Col. Pct.)	HID	No HID	Total
Yes (small round, opaque lens)	591 (56.50)	117 (29.18)	708 (48.93)
No	272 (26.00)	189 (47.13)	461 (31.86)
Don't Know	183 (17.50)	95 (23.69)	278 (19.21)
Total	1,046	401	1,447
Row Pct.	72.29	27.71	100.00

Table 9. Apparent beam pattern for HID headlamps and non-HID headlamps (Q15)

Frequency (Col. Pct.)	HID	No HID	Total
A (sharp cut-off)	699 (65.76)	190 (46.80)	889 (60.52)
B (fuzzy cut-off)	121 (11.38)	79 (19.46)	200 (13.61)
Don't Know	243 (22.86)	137 (33.74)	380 (25.87)
Total	1,063	406	1,469
Row Pct.	72.36	27.64	100.00

Note that in all of the analyses described below, responses to only a few items depended significantly on apparent headlamp beam pattern (Q15) or apparent type of headlamp optics (Q14). Analyses based on these factors are discussed only where they had a significant effect or where they were expected to have a significant effect.

6. Headlamp Glare

This section summarizes items related to headlamp glare including respondents' experience with glare from other vehicles' headlamps as well as the potential for their headlamps to cause glare for other drivers.

Checking or adjusting headlamp aim

"I did have problems with people flashing their lights at me. I went to the dealer and had him lower the lights, which helped, although I can't see as far now." (Female, 34)

"[My vehicle's] headlights can not be adjusted by the dealers. The lights were great for me at the expense of other drivers. I was illuminating signs and the side of the road 20 feet up! Other drivers were constantly flashing me. I went to two dealer service departments about that, wrote and called [. . .] and got nowhere." (Male, 81)

Vehicle owners in California are not required to have any periodic inspection of their headlamp aim. Only 14 percent of respondents said they ever had the aim of the headlamps on their current vehicle checked or adjusted (Q6). The proportion of respondents who had done this was the same among HID headlamp owners and among those without HID headlamps, but it did differ significantly by vehicle manufacturer, $\chi^2(5) = 13.4, p < .05$, from 10.3 percent (Toyota) to 18.6 percent (Mercedes-Benz).

As vehicles accumulate more mileage, it is more likely that the headlamps may become misaligned. Therefore, it was expected that the proportion of vehicle owners who had their headlamp alignment checked or adjusted would increase with their level of vehicle experience (miles driven). Table 10 shows the number of respondents with different levels of vehicle experience who have (Yes) and have not (No) ever had the aim of their headlamps checked or adjusted (Q6). The proportion of respondents who said they had their headlamps' aim checked depends significantly on experience level, $\chi^2(4) = 15.6, p < .01$. As expected, the percentage of respondents who ever had their headlamp alignment checked is highest (16.8%) for those with 30,000 or more miles of driving experience with the vehicle; however this percentage does not decrease systematically at lower levels of driving experience.

Table 10. Respondents who have had their headlight alignment checked by level of vehicle experience

Frequency Row Pct. (Col. Pct.)	Less than 5,000 Miles	5,000 to 9,999 Miles	10,000 to 19,999 Miles	20,000 to 29,999 Miles	30,000 or More Miles	Total
Yes	20 7.52 (13.51)	24 9.02 (11.82)	53 19.92 (11.30)	40 15.04 (9.48)	129 48.50 (16.82)	266 (13.24)
No	128 7.34 (86.49)	179 10.27 (88.18)	416 23.87 (88.70)	382 21.92 (90.52)	638 36.60 (83.18)	1,743 (86.76)
Total	148 7.37	203 10.10	469 23.34	422 21.01	767 38.18	2,009 100.00

The reasons cited by respondents for having their headlamps checked are given in Appendix B. Among those who had the aim of their headlamps checked, the most common reason for doing so (cited by 80.3 percent of the respondents) was, "The service was offered during maintenance." The proportion of respondents who cited this reason did not depend significantly on vehicle manufacturer, $\chi^2(5) = 5.8, p = .32$. None of the respondents said they had been required to have their headlamp aim checked because they had been stopped by law enforcement. The proportion of respondents who said they had their headlamps checked because they were concerned about causing glare or distraction to other drivers was slightly higher among HID headlamp owners (22%) than among non-HID headlamp owners (18%), but this difference was not statistically significant, $\chi^2(1) = 0.4, p = .52$. Only 9 percent of respondents who had their headlamps checked said a reason for doing so was, "Oncoming vehicles kept flashing their headlights at me." The proportion of respondents citing this reason

was not significantly different for HID headlamp owners as compared to non-HID headlamp owners, $\chi^2(1) = 0.1, p = .74$.

Other drivers flashing their high beams

Drivers who are bothered by the brightness of an oncoming vehicle’s headlamps may flash their own high beams on and off to signal the other driver that the driver’s high beams may be on. In some cases, the other drivers may be driving with their high beams on but in other cases the other driver’s low beams may be misaimed and the resulting glare may appear to other drivers as if the high beams were on. When only the vehicle’s low beams are on, the amount of high-beam flashing received from other drivers provides an indication of the annoyance caused by a driver’s headlamps. Based on public comments received by NHTSA, HID headlamps (low beams) were expected to produce more annoyance than conventional headlamps. Some comments from the telephone interviews are given below:

“I find the [HID] lights produce a blinding white light. My car sits low to the ground and I still have other drivers flash me on a regular basis thinking I have the high beams on when I don't [...] From a driver’s standpoint I love the lights.” (Female, 57)

“I primarily drive in the city and the [HID] headlights work fine. I haven't had any problems with people flashing me or things like that.” (Female, 63)

“I feel the HID lights are too bright for oncoming cars; about 1 in 10 cars flash me when I'm on two lane roads.” (Female, 40)

Item Q8 asked respondents, “When driving at night, how often do other drivers flash their high beams at you, even though you have your low beams on?” Overall, 84 percent of respondents said this happens, “Never or almost never,” and less than two percent said either, “Frequently” or “Every time or nearly every time I drive at night.” The response frequencies are shown in Table 11 for HID headlamp owners and non-HID headlamp owners.

Table 11. HID and non-HID headlamp owners receiving high-beam flashes from other drivers

Frequency (Col. Pct.)	HID	No HID	Total
Never or almost never	889 (81.86)	377 (89.55)	1,266 (84.01)
Occasionally	177 (16.30)	39 (9.26)	216 (14.33)
Frequently	16 (1.47)	5 (1.19)	21 (1.39)
Every time or nearly every time I drive at night	4 (0.37)	0 (0.00)	4 (0.27)
Total	1,086	422	1,507
Row Pct.	72.06	27.94	100.00

For subsequent analyses, the response categories, “Occasionally,” “Frequently,” and “Every time or nearly every time I drive at night” were combined. The number of respondents who said, “Occasionally” (or more frequently) was compared to the number of respondents who said, “Never or almost never.” HID headlamp owners were significantly more likely than non-HID headlamp owners to report high-beam flashes at least occasionally from other drivers, $z = 4.06, p < .001$. As described below, these differences were not related to the sharpness of the beam pattern or type of headlamp optics (projector optics versus non-projector optics).

In Figure 5 the percentage of respondents who reported other drivers flashing their headlamps at them at least occasionally is shown for HID headlamp owners and non-HID headlamp owners for three different levels of experience with the vehicle. Only those respondents who said they had never had the aim of their headlamps checked or adjusted were included in this analysis. It is reasonable to assume that in states such as California where periodic headlamp alignment checks are not required, headlamp misalignments are more likely to be found on vehicles that have been driven more miles. The percentage of respondents with HID headlamps who experience high-beam flashes from other drivers (at least occasionally) depends significantly on vehicle experience, $\chi^2(2) = 8.3, p < .05$, and nearly doubles from 11.9 percent to 22.3 percent across increasing experience categories. By contrast, the percentage of non-HID headlamps owners who receive high-beam flashes from other drivers does not differ significantly with vehicle experience, $\chi^2(2) = 4.4, p = .11$ and is consistently lower than for those with HID headlamps at all experience levels. The general pattern of results shown in Figure 5 holds for both older and younger respondents.

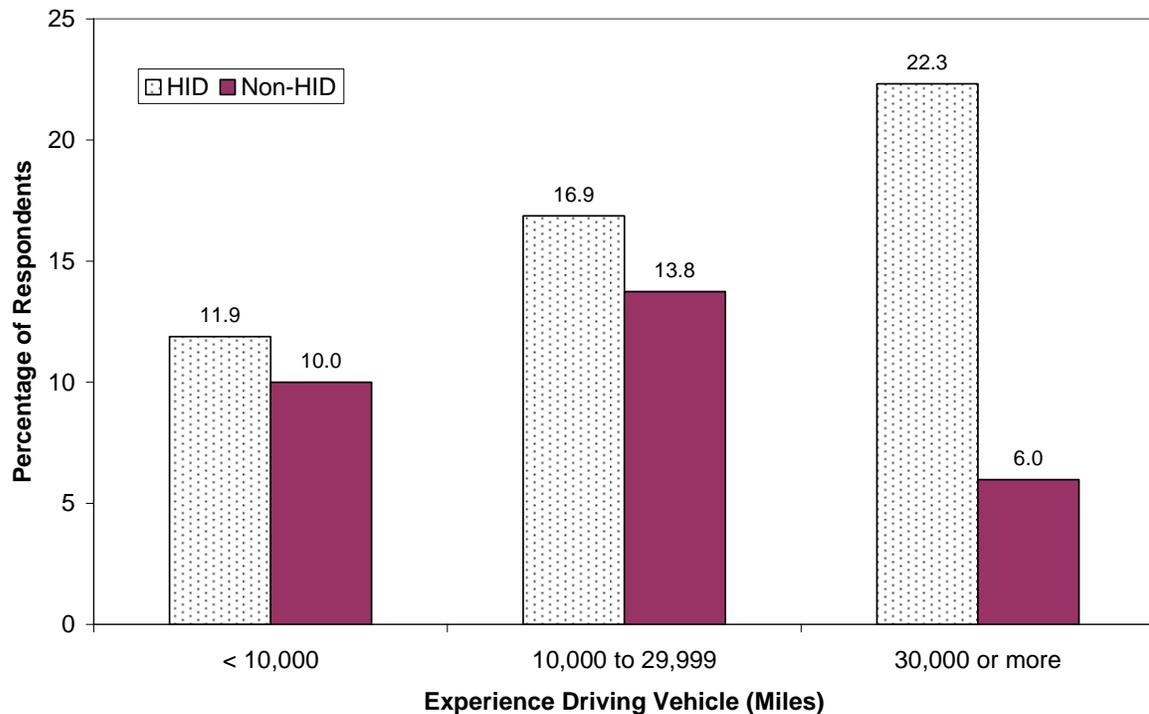


Figure 5. Respondents with HID and non-HID headlamps who report that oncoming drivers flash their high beams at them, for three levels of vehicle experience

Besides the type of headlamp light source, (HID versus non-HID) it is possible that beam pattern and headlamp optics may be related to glare for oncoming drivers. Among all respondents, those who said their headlamps had a sharp cut-off beam pattern (Q15) were not significantly more or less likely than those with a fuzzy beam pattern to report at least occasional high-beam flashes from other drivers (Q8), $z = .59, p = .55$. Also, when analyzed separately, neither the responses of HID headlamp owners to item Q8, nor the responses of non-HID headlamp owners to item Q8 were significantly related to beam pattern type. Also, among those who did not know whether they had HID headlamps or not, the effect of beam pattern type was not significantly related to having other drivers flash their high beams, $z = .22, p = .83$.

The possible effect of headlamp optics type (projector optics versus non-projector optics) on glare for oncoming drivers was examined by comparing responses from all vehicle owners who said their low beam headlamp looked like the headlamp with projector optics pictured in item Q14 to responses from vehicle owners who said their headlamps did not look like the headlamp pictured in item Q14. Those who said they didn't know were excluded from the analysis. Sixteen percent of respondents who said they have projector optics said other drivers flashed their headlamps at them at least occasionally as compared to 12 percent of respondents without projector optics. This difference was statistically significant, $z = 2.15, p < .05$. Among HID headlamp owners, there was no difference between those with and without projector optics in the percentage of respondents who reported being flashed by other drivers

(17 percent in both cases). Among those who did not have HID headlamps, 13 percent of those with projector optics and 6.5 percent of those without projector optics said other drivers flashed their high beams at them at least occasionally. This difference nearly reached the criterion ($\alpha = .05$) for statistical significance, $z = 1.956$, $p = .052$. Finally, among those who did not know whether they had HID headlamps, the effect of headlamp optics type was not significantly related to having other drivers flash their high beams, $z = 1.08$, $p = .28$.

The proportion of all respondents who reported at least occasional high-beam flashes from other drivers (Q8) depended significantly on the respondents' vehicle manufacturer, $\chi^2(5) = 16.3$, $p < .01$, ranging from 8.2 percent (Audi) to 19.4 percent (Acura). However, the two analyses described below suggest that this difference may be due to the proportion of respondents with HID headlamps per vehicle manufacturer rather than differences between vehicle manufacturers per se. Among respondents with HID headlamps, the responses to item Q8 did not depend significantly on vehicle manufacturer, $\chi^2(5) = 8.9$, $p < .11$.

Two logistic regression models were used to investigate how sets of variables together may be used to predict whether or not respondents reported that other drivers flashed their high beams at them. The first model included the following predictor variables: headlamp type (HID or non-HID), projector optics (yes or no), headlamp beam pattern (sharp cut-off or fuzzy), age group (<65 or ≥ 65), gender (male or female), and an intercept parameter. Respondents who did not answer or said they didn't know the answer to any of these items were excluded from this analysis resulting in a sample of $n = 922$ cases. The only predictor variable in the model that was statistically significant (based on a likelihood ratio statistic) was headlamp type, $\chi^2(1) = 8.5$, $p < .01$. Thus, when controlling for age group, gender, beam pattern, and headlamp optics, headlamp type (HID or non-HID) was a significant predictor of whether respondents reported receiving high-beam flashes from other drivers.

A second logistic regression model included headlamp type (HID or non-HID), vehicle manufacturer (Acura, Audi, BMW, Mercedes-Benz, Nissan, and Toyota), age group, gender, and an intercept parameter. A sample of $n = 1,249$ cases was analyzed. In this analysis, only headlamp type (HID versus non-HID) was a statistically significant predictor of reporting at least occasional high-beam flashes from other drivers, $\chi^2(1) = 4.1$, $p < .05$.

Experiencing glare from other vehicles' headlamps

*"I do experience problems with the glare of other HID-equipped vehicles."
(Female, 80)*

"The only problem I have is with other drivers flashing their lights at me because [my HID headlamps] are very bright. I also have problems with other drivers' HID lights in my side rearview mirrors blinding me." (Female, 34)

Items Q10 to Q13 asked respondents about their experience with glare from oncoming vehicles and from vehicles behind them. The response frequencies for these items are shown in Appendix B. Approximately 29 percent of the respondents said in the last six months, while driving at night, the light from oncoming vehicles generally has been, "Annoying," and 6 percent said it has been, "Blinding/disturbing" (Q10). Similarly, approximately 26 percent of respondents found the light from vehicles behind them to be "Annoying," and 5 percent of respondents said it has been "Blinding/disturbing" (Q12). The distribution of responses to

Item Q10 (light from oncoming vehicles) did not differ significantly between younger and older respondents, $\chi^2(2) = 4.8, p = .09$. The distribution of responses to Item Q12 (light from vehicles behind) also did not differ significantly between younger and older respondents, $\chi^2(2) = 3.5, p = .17$.

The perception of glare from oncoming vehicles (Q10) depended significantly upon whether the respondents had HID headlamps or non-HID headlamps, $\chi^2(2) = 16.1, p < .001$. Respondents with HID headlamps were more likely than respondents without HID headlamps to find the light from oncoming vehicles acceptable. These results are shown in Table 12.

It is possible that the brighter light produced by HID headlamps may mitigate the effects of glare from oncoming vehicles by keeping the HID headlamp owner's visual system adapted to higher light levels and by providing more light on the roadway ahead to overcome the masking effects of the veiling luminance from the oncoming headlamps.

Table 12. Respondents' perception of light from oncoming vehicles (Q10) by own headlamp type

Frequency (Col. Pct.)	HID	No HID	Total
Blinding (or) Disturbing	59 (5.36)	27 (6.31)	86 (5.62)
Annoying	279 (25.34)	150 (35.05)	429 (28.06)
Acceptable	763 (69.30)	251 (58.64)	1,014 (66.32)
Total	1,101	428	1,529
Row Pct.	72.01	27.99	100.00

Further analyses by age group revealed that among younger respondents, the effect of HID versus non-HID headlamps on the perception of light from oncoming vehicles was not significant, $\chi^2(2) = 4.1, p = .13$. However, among older respondents, the effects of light from oncoming vehicles depended significantly on whether the respondents had HID headlamps, $\chi^2(2) = 7.6, p < .05$. Older respondents with HID headlamps were more likely to find light from oncoming vehicles acceptable as compared to older respondents without HID headlamps. These results are shown in Table 13.

Table 13. Older respondents' perception of light from oncoming vehicles (Q10) by own headlamp type

Frequency (Col. Pct.)	HID	No HID	Total
Blinding (or) Disturbing	21 (5.88)	19 (6.62)	40 (6.21)
Annoying	95 (26.61)	104 (36.24)	199 (30.90)
Acceptable	241 (67.51)	164 (57.14)	405 (62.89)
Total	357	287	644
Row Pct.	55.43	44.57	100.00

With regard to light from vehicles behind (Q12), headlamp type was not significantly related to the perception of glare for younger respondents, $\chi^2(2) = 3.1, p = .21$, nor was it related to the perception of glare for older respondents, $\chi^2(2) = 3.1, p = .21$.

Behavioral responses to headlamp glare

"I have had no problems except for the SUVs blasting [me] from behind, causing me to adjust my mirror to avoid their lights, then I can't see behind me." (Male, 68)

Respondents were asked to report which of several behaviors they had done in the last six months in response to light from oncoming vehicles (Q11) and in response to light from vehicles behind (Q13). The response frequencies are given in Appendix B. Approximately half of the respondents to each of these questions reported that light from other vehicles has not caused them to engage in any of the behaviors listed.

In response to light from oncoming vehicles (Q11), a third of the respondents said they "Look to the right side of the roadway, away from the roadway directly ahead," and 16 percent said they "Block the light with my hands." Seven percent of respondents said they "Slow down or stop until the oncoming light has passed," 6 percent "Limit the amount of driving that [they] do at night," and 2.6 percent said they "Avoid driving on unlighted two-lane roads." None reported they had unintentionally driven off the road, and only three (0.14%) reported that they had a crash or close call. Younger respondents were more likely (19%) than older respondents (12%) to "Block the light with [their] hands," $\chi^2(1) = 18.3, p < .001$. Older respondents were more likely (10.8%) than younger respondents (2.5%) to "Limit the amount of driving that [they] do at night," $\chi^2(1) = 61.0, p < .001$. Older respondents (3.7%) were also more likely to "Avoid driving on unlighted two-lane roads," $\chi^2(1) = 7.7, p < .01$. None of the other responses to item Q11 differed significantly between age groups.

In response to light from vehicles behind (Q13), a third of the respondents said they "Turn the inside rear-view mirror to the 'dim' position, or move the mirror itself," and 26 percent said they "Move my head or eyes away from the light reflected from my mirrors." Approximately 12 percent of respondents said they "Block the light with my hands." Two percent of respondents said they "Slow down or stop until the oncoming light has passed or turned off the road," and 3.5 percent said they "Limit the amount of driving that [they] do at night." None

reported they had unintentionally driven off the road, and none reported they had a crash or close call. Younger respondents (16%) were twice as likely as older respondents (8%) to “Block the light with [their] hands,” $\chi^2(1) = 30.2, p < .001$. Younger respondents (31%) were more likely than older respondents (20%) to report they “Move my head or eyes away from the light reflected from my mirrors.” Older respondents were more likely (6.3%) than younger respondents (1.2%) to “Limit the amount of driving that [they] do at night,” $\chi^2(1) = 39.8, p < .001$. None of the other responses to item Q13 differed significantly between age groups.

A long-term behavioral response to glare may be revealed by consumers’ purchasing decisions. Nearly 17 percent of the respondents without HID headlamps said they didn’t choose to get HID headlamps because they thought they would be a nuisance or distraction to other drivers.

7. Behavioral Adaptation to Headlamps

“[With HID headlamps,] I have changed my driving habits; I drive a little faster at night and especially in bad weather because I can see about 40% better than before. It didn’t take any time, you can see much better instantly. When I drive rentals with out HID lights I have to adjust back!” (Male, 39)

“I don’t see any better with the HID lights than my older halogen lights. I can’t drive any faster than before.” (Male, 73)

“I haven’t changed my driving habits because of [HID headlamps], I’m still not used to them! (Female, 58)

“Yes, I have changed my driving habits; I have to be a little more cautious since I can’t see as far down the road.” (Female, 49)

“I haven’t changed my driving habits that I’m aware of. I got used to the HID lights in no time.” (Male, 72)

Item Q21 asked respondents, “If your headlight system had to be replaced with conventional headlights, how would your driving behavior change?” Approximately 70 percent of those with HID headlamps said their behavior would not change. Nearly 18 percent said they would drive more slowly at night than they do now. Other respondents said they would limit where or when they drive, by avoiding unfamiliar places at night (10%), avoiding dark roads (11%), or limiting the amount of nighttime driving (9%). A few respondents offered other responses, saying they would increase the use of their high beams or pay more attention to the driving task.

Similar issues were addressed by item Q22. The percentage of respondents with HID headlamps who agreed or strongly agreed with each of these statements is given below:

- 58 percent - “I use the high beams less often than I would if I had conventional headlights,” (Q22A). Responses to this item depended significantly on age group, $\chi^2(4) = 17.0, p < .01$, and are shown in Table 14. Younger respondents were more likely than older respondents to “strongly agree” with the statement (but were less likely to simply “agree.”) Responses to this item depended significantly on whether the respondent had headlamps with projector optics (Q14), $\chi^2(4) = 11.2, p < .05$. Sixty-one percent of

those with projector optics and 52 percent of those without projector optics agreed or strongly agreed. Responses to this item also significantly on vehicle manufacturer, $\chi^2(20) = 33.3, p < .05$, as shown in Table 15.

- 40 percent – “I am more willing to drive at night with my headlights than with conventional headlights,” (Q22C). Responses to this item depended significantly on age group, $\chi^2(4) = 10.1, p < .05$, and are shown in Table 16. Younger respondents were more likely than older respondents to “strongly agree” with the statement (but were less likely to simply “agree.”) Responses to this item also significantly on vehicle manufacturer, $\chi^2(20) = 36.0, p < .05$ as shown in Table 17.
- 23 percent – “I am willing to drive faster using my headlights’ low beams than with the low beams from conventional headlights,” (Q22D). Responses to this item did not depend significantly on age group, $\chi^2(4) = 1.9, p = .74$.

Table 14. I use the high beams less often than I would if I had conventional headlights. (Q22A) by age group

Frequency (Col. Pct.)	Less than 65 years	65 or older	Total
Strongly Disagree	69 (9.49)	19 (5.67)	88 (8.29)
Disagree	80 (11.00)	50 (14.93)	130 (12.24)
Neutral	146 (20.08)	85 (25.37)	231 (21.75)
Agree	257 (35.35)	127 (37.91)	384 (36.16)
Strongly Agree	175 (24.07)	54 (16.12)	229 (21.56)
Total	726	335	1,062
Row Pct.	68.43	31.57	100.00

Table 15. I use the high beams less often than I would if I had conventional headlights. (Q22A) by vehicle manufacturer

Frequency (Col. Pct.)	Acura	Audi	BMW	Mercedes-Benz	Nissan	Toyota	Total
Strongly Disagree	36 (7.96)	6 (13.95)	10 (9.09)	3 (8.33)	15 (6.17)	2 (6.67)	72 (7.88)
Disagree	58 (12.83)	3 (6.98)	12 (10.91)	10 (27.78)	25 (10.29)	2 (6.67)	110 (12.04)
Neutral	102 (22.57)	10 (23.26)	15 (13.64)	9 (25.00)	65 (26.75)	7 (23.33)	208 (22.76)
Agree	152 (33.63)	12 (27.91)	44 (40.00)	6 (16.67)	94 (38.68)	16 (53.33)	324 (35.45)
Strongly Agree	104 (23.01)	12 (27.91)	29 (26.36)	8 (22.22)	44 (18.11)	3 (10.00)	200 (21.88)
Total	452	43	110	36	243	30	914
Row Pct.	49.45	4.70	12.04	3.94	26.59	3.28	100.00

Table 16. I am more willing to drive at night with my headlights than with conventional headlights. (Q22C) by age group

Frequency (Col. Pct.)	Less than 65 years	65 or older	Total
Strongly Disagree	59 (8.12)	17 (5.09)	76 (7.16)
Disagree	88 (12.10)	38 (11.38)	126 (11.88)
Neutral	296 (40.72)	142 (42.51)	438 (41.28)
Agree	147 (20.22)	89 (26.65)	236 (22.24)
Strongly Agree	137 (18.84)	48 (14.37)	185 (17.44)
Total	727	334	1,061
Row Pct.	68.52	31.48	100.00

Table 17. I am more willing to drive at night with my headlights than with conventional headlights. (Q22C) by vehicle manufacturer

Frequency (Col. Pct.)	Acura	Audi	BMW	Mercedes- Benz	Nissan	Toyota	Total
Strongly Disagree	34 (7.57)	6 (13.95)	6 (5.36)	1 (2.78)	14 (5.76)	2 (6.67)	63 (6.90)
Disagree	52 (11.58)	6 (13.95)	7 (6.25)	9 (25.00)	29 (11.93)	5 (16.67)	108 (11.83)
Neutral	195 (43.43)	14 (32.56)	48 (42.86)	11 (30.56)	111 (45.68)	7 (23.33)	386 (42.28)
Agree	95 (21.16)	4 (9.30)	26 (23.21)	9 (25.00)	56 (23.05)	12 (40.00)	202 (22.12)
Strongly Agree	73 (16.26)	13 (30.23)	25 (22.32)	6 (16.67)	33 (13.58)	4 (13.33)	154 (16.87)
Total	449	43	112	36	243	30	913
Row Pct.	49.18	4.71	12.27	3.94	26.62	3.29	100.00

8. Perceived Effectiveness of Headlamps

“The low beam appears flat on top which limits the range when approaching a hill, I need to use the high beams on unlighted roads when doing that, otherwise the HID lights offer excellent light to the sides to see pedestrians and animals.” (Male, 73)

“I don't like the headlights. They have a sharp jagged stair-step cut-off with the driver's side lower than the passenger side. On mountain roads when the road curves left you can't see very far and must be very careful, I keep the car between the lines and this makes it difficult to see.” (Female, 49)

“I find the lights especially beneficial when driving on the twisty, turning roads I encounter in northern California that are relatively unlit, the HID lights with their longer range is especially useful. I haven't had any problems with the lights.” (Male, 72)

“I'm pleased with the HID lights performance. They have an ideal compromise by cutting off the top of the light beam and still lighting the road.” (Male, 71)

Perceived effectiveness of HID headlamps was assessed using two strategies. The first strategy was to ask respondents with HID headlamps to compare their headlamps to conventional headlamps, and the second strategy was to ask all respondents how well they could see using their headlamps under a variety of specific situations. Responses from those with HID headlamps were then compared to responses from those who did not have HID headlamps.

The percentage of respondents with HID headlamps who agreed or strongly agreed with each of the following statements (from item Q22) is given below:

- 61 percent – “I feel less eyestrain driving at night with my headlights than with conventional headlights,” (Q22B). Responses to this item depended significantly on age group, $\chi^2(4) = 11.4$, $p < .05$, and are shown in Table 18. Younger respondents were more likely than older respondents to strongly agree with the statement.
- 75 percent - “I prefer my headlights to conventional headlights,” (Q22E). Responses to this item depended significantly on age group, $\chi^2(4) = 26.3$, $p < .001$, and are shown in Table 19. Younger respondents were more likely than older respondents to strongly agree with the statement.

Table 18. “I feel less eyestrain driving at night with my headlights than with conventional headlights,” (Q22B) by age group

Frequency (Col. Pct.)	Less than 65 years	65 or older	Total
Strongly Disagree	38 (5.23)	14 (4.18)	52 (4.90)
Disagree	33 (4.55)	23 (6.87)	56 (5.28)
Neutral	197 (27.13)	109 (32.54)	306 (28.84)
Agree	273 (37.60)	130 (38.81)	403 (37.98)
Strongly Agree	185 (25.48)	59 (17.61)	244 (23.00)
Total	726	335	1,061
Row Pct.	68.43	31.57	100.00

Table 19. “I prefer my headlights to conventional headlights,” (Q22E) by age group

Frequency (Col. Pct.)	Less than 65 years	65 or older	Total
Strongly Disagree	49 (6.75)	18 (5.41)	67 (6.33)
Disagree	21 (2.89)	20 (6.01)	41 (3.87)
Neutral	93 (12.81)	62 (18.62)	155 (14.64)
Agree	179 (27.13)	114 (34.23)	311 (29.37)
Strongly Agree	366 (50.41)	119 (35.74)	485 (45.80)
Total	726	333	1,059
Row Pct.	68.56	31.44	100.00

Visibility under four driving scenarios (with HID versus non-HID headlamps)

Perceived effectiveness of headlamps was assessed by asking all respondents how well they could see while driving at night under four different driving scenarios. Item Q9 asked, “How easy is it for you to see each of the following while driving at night?” The four scenarios were:

- Q9A – On curved roads, how easy is it for you to see lane lines using your low beams?
- Q9B – How easy is it for you to read overhead road signs that are not lighted except by your headlights’ low beams?

- Q9C – On roads without street lights, how easy is it for you to see pedestrians on or near the road using your low beams?
- Q9D – When you approach a hill how easy is it for you to see the roadway up the hill ahead using your low beams?

Overall response frequencies for all respondents are show in Appendix B. Responses to items Q9A – Q9D for those with and without HID headlamps were compared and are shown in Tables 20 – 23. Due to the small counts within some of the cells of these tables, the differences between HID headlamp owners and non-HID headlamp owners responses were tested by combining the “Very Easy” and “Somewhat Easy” responses and comparing them to the combined “Somewhat Difficult” and “Very Difficult” responses. The “Don’t Know” responses were excluded from these analyses.

The responses for those with and without HID headlamps were significantly different for item Q9A, $\chi^2(1) = 18.2, p < .001$; item Q9B, $\chi^2(1) = 45.3, p < .001$; item Q9C, $\chi^2(1) = 39.8, p < .001$ and item Q9D, $\chi^2(1) = 14.4, p < .001$. Respondents with HID headlamps were more likely than those without HID headlamps to say that it is “Easy” (or “Very Easy”) for them to see in each of the four scenarios described.

Table 20. “On curved roads, how easy is it for you to see lane lines using your low beams?” (Q9A) by headlamp type

Frequency (Col. Pct.)	HID	No HID	Total
Very Easy	726 (67.04)	206 (49.40)	932 (62.13)
Somewhat Easy	278 (25.67)	151 (36.21)	429 (28.60)
Somewhat Difficult	54 (4.99)	44 (10.55)	98 (6.53)
Very Difficult	7 (0.65)	6 (1.44)	13 (0.87)
Don’t Know	18 (1.66)	10 (2.40)	28 (1.87)
Total	1083	417	1500
Row Pct.	72.20	27.80	100.00

Table 21. “How easy is it for you to read overhead road signs that are not lighted except by your headlights’ low beams?” (Q9B) by headlamp type

Frequency (Col. Pct.)	HID	No HID	Total
Very Easy	420 (38.89)	96 (23.19)	516 (34.54)
Somewhat Easy	428 (39.63)	161 (38.89)	589 (39.42)
Somewhat Difficult	159 (14.72)	106 (25.60)	265 (17.74)
Very Difficult	41 (3.80)	38 (9.18)	79 (5.29)
Don’t Know	32 (2.96)	13 (3.14)	45 (3.01)
Total	1080	414	1494
Row Pct.	72.29	27.71	100.00

Table 22. On roads without street lights, how easy is it for you to see pedestrians on or near the road using your low beams? (Q9C) by headlamp type

Frequency (Col. Pct.)	HID	No HID	Total
Very Easy	453 (41.87)	95 (22.78)	548 (36.56)
Somewhat Easy	380 (35.12)	163 (39.09)	543 (36.22)
Somewhat Difficult	162 (14.97)	112 (26.86)	274 (18.28)
Very Difficult	49 (4.53)	34 (8.15)	83 (5.54)
Don’t Know	38 (3.51)	13 (3.12)	51 (3.40)
Total	1082	417	1499
Row Pct.	72.18	27.82	100.00

Table 23. When you approach a hill how easy is it for you to see the roadway up the hill ahead using your low beams? (Q9D) by headlamp type

Frequency (Col. Pct.)	HID	No HID	Total
Very Easy	411 (38.02)	105 (25.18)	516 (34.45)
Somewhat Easy	408 (37.74)	175 (41.97)	583 (38.92)
Somewhat Difficult	177 (16.37)	100 (23.98)	277 (18.49)
Very Difficult	35 (3.24)	20 (4.80)	55 (3.67)
Don't Know	50 (4.63)	17 (4.08)	67 (4.47)
Total	1081	417	1498
Row Pct.	72.16	27.84	100.00

Because HID headlamp owners who responded to the survey tended to be younger (with better vision) than respondents without HID headlamps, the results described above could be due to age effects, rather than HID headlamps, per se. To check for this possibility, the statistics described above were calculated separately for the younger and older groups of respondents. For items Q9A – Q9C the differences between respondents with and without HID headlamps were statistically significant for both younger and older respondents. For item Q9D, the differences between responses from HID owners and non-HID owners were statistically significant among the younger group, $\chi^2(1) = 12.3, p < .001$, but were not significant among the older group, $\chi^2(1) = .9, p = .32$. Table 24 shows the combined percentage of “Very Easy” and “Somewhat Easy” responses for items Q9A – Q9D for younger and older respondents who have HID headlamps and non-HID headlamps.

Table 24. Percentage of older and younger respondents with and without HID headlamps who said it was “very easy” or “somewhat easy” to see in four visibility scenarios

Percentage of “very easy” and “somewhat easy” responses	Younger with HID	Younger with No HID	Older with HID	Older with No HID
Q9A – On curved roads, how easy is it for you to see lane lines using your low beams?	95.0	88.7	92.7	87.2
Q9B – How easy is it for you to read overhead road signs that are not lighted except by your headlights’ low beams?	86.0	75.8	70.2	58.4
Q9C – On roads without street lights, how easy is it for you to see pedestrians on or near the road using your low beams?	80.9	61.4	77.5	65.1
Q9D – When you approach a hill how easy is it for you to see the roadway up the hill ahead using your low beams?	81.9	68.5	74.3	70.7

Visibility under four driving scenarios (relation to headlamp beam pattern)

Similar analyses to those described above were conducted based on respondents’ reported headlamp beam patterns (Q8) and type of headlamp optics (Q14). The responses from all respondents who reported having a sharp cut-off beam pattern were significantly different from those who said they have a fuzzy beam pattern for item Q9A, $\chi^2(1) = 13.1, p < .001$; item Q9C, $\chi^2(1) = 16.2, p < .001$ and item Q9D, $\chi^2(1) = 6.2, p < .05$. The responses for item Q9B did not depend significantly on reported type of beam pattern, $\chi^2(1) = 2.2, p = .13$. Respondents who have a sharp cut-off beam pattern were more likely than those with a fuzzy beam pattern to say it is “Easy” (or “Very Easy”) for them to see in the scenarios described in Q9A, Q9C, and Q9D. Among HID headlamp owners (who reported their beam pattern type), only the responses to scenario Q9A depended significantly on reported beam pattern, $\chi^2(1) = 6.4, p < .05$. Approximately 95 percent of HID headlamp owners with a sharp cut-off beam pattern said, “Easy” or “Very Easy” to scenario Q9A, as did 90 percent of HID headlamp owners who reported having a fuzzy beam pattern.

Visibility under four driving scenarios (relation to headlamp optics)

The responses from all respondents who reported having projector optics (similar to the picture shown on item Q14) were significantly different from those who said they do not have headlamps with projector optics for item Q9B (overhead signs), $\chi^2(1) = 6.1, p < .05$; and for

item Q9D (approaching a hill), $\chi^2(1) = 4.0, p < .05$. For these analyses, the respondents who didn't know whether their headlamps looked like the one pictured in item Q14 were excluded. Approximately 77 percent of those with projector optics and 71 percent of those without projector optics said it is very easy or somewhat easy to read overhead signs, while 78 percent of those with projector optics and 73 percent of those without projector optics said it is very easy or somewhat easy to see the roadway ahead when approaching a hill.

Neither the responses to items concerning curved roads (Q9A) nor pedestrians (Q9C) depended significantly on headlamp optics type. Among respondents who have HID headlamps, only the responses to item Q9B depended significantly on headlamp optics type, $\chi^2(1) = 6.9, p < .01$, with 83 percent of those with projector optics and 76 percent of those without projector optics saying it is very easy or somewhat easy to read overhead signs. Among respondents with conventional headlamps (non-HID) none of the responses to items Q9A – Q9D depended significantly on headlamp optics type (Q14).

Visibility under four driving scenarios (results from logistic regression models)

Logistic regression analyses were used to investigate how responses to items Q9A – Q9D may be related to headlamp type, headlamp beam pattern, headlamp optics, and the respondent's age group when these factors are all considered together. Separate models were created for responses to items Q9A – Q9D. The dependent variable in each model represented whether or not the respondent said seeing was "easy" (including "very easy" and "somewhat easy") in the particular scenario described (e.g. Q9A). Each model included the factors listed above as binary predictor variables and an intercept parameter. Respondents who said they "didn't know" to questionnaire items about their headlamp type, beam pattern, or headlamp optics were excluded from these analyses. Table 25 shows a summary of the results for fitting the models to the data for items Q9A – Q9D. The columns represent each of the predictive variables used in the models. A plus (+) or minus (-) sign indicates that the parameter was statistically significant (at the confidence level given in parentheses) based on a likelihood ratio statistic (χ^2). The statistical criterion of $p < .10$ was used in these analyses to ensure that even relatively weak statistical relationships that may have practical significance would be noted. A plus sign indicates that the parameter as described in the column heading was associated with an increase in the percentage of "easy" responses to the questionnaire item listed in that row, and a minus sign indicates that the parameter was associated with a reduction in the percentage of "easy" responses. Cells containing "NS" show

the column parameter was not a statistically significant predictor of "easy" responses.

Respondents were more likely to say that seeing lane lines on curved roads is easy (Q9A) if they had HID headlamps, headlamps with a sharp cut-off beam pattern, did not have headlamps with projector optics, and were in the younger age group. Similarly, respondents were more likely to say that seeing pedestrians is easy (Q9C) if they had HID headlamps, headlamps with a sharp cut-off beam pattern, did not have headlamps with projector optics, and were in the younger age group. The only statistically significant predictor in the models for items Q9B and Q9D was age group.

Table 25. Statistically significant model parameters for predicting “easy” to see responses in four visibility scenarios (all age groups)

Influence of predictor variables in regression models for items below	Having HID headlamps	Having headlamps with a sharp cut-off beam pattern	Having headlamps with projector optics	Being in the younger age group
Q9A – On curved roads, how easy is it for you to see lane lines using your low beams?	+	+	-	+
	($p < .10$)	($p < .10$)	($p < .10$)	($p < .01$)
Q9B – How easy is it for you to read overhead road signs that are not lighted except by your headlights’ low beams?	NS	NS	NS	+
	($p = .11$)	($p = .27$)	($p = .70$)	($p < .001$)
Q9C – On roads without street lights, how easy is it for you to see pedestrians on or near the road using your low beams?	+	+	-	+
	($p < .01$)	($p < .01$)	($p < .05$)	($p < .05$)
Q9D – When you approach a hill how easy is it for you to see the roadway up the hill ahead using your low beams?	NS	NS	NS	+
	($p = .23$)	($p = .16$)	($p = .58$)	($p < .10$)

Due to the statistically significant predictive effects of age group on respondents’ answers to all items Q9A-Q9D, the data for younger respondents and older respondents was modeled separately. Figure 26 shows a summary of results for fitting logistic regression models to older respondents’ data and Figure 27 shows the results for fitting models to younger respondents’ data. Each model included the predictive variables shown in the table column headings and an intercept parameter. The patterns of results are different in these two figures indicating that the particular features of headlamps that are predictive for seeing more easily in the given scenarios differ between younger and older respondents. Older respondents were more likely to say they could see well in scenarios Q9A, Q9B, and Q9C if they had HID headlamps, whereas having HID headlamps for younger respondents was predictive for seeing more easily only in scenario Q9C. Having headlamps with a sharp cut-off beam pattern was predictive of an increase in easy-to-see responses on item Q9B for older respondents and on items Q9A and Q9C for younger respondents. Having headlamps with projector optics was predictive of a lower proportion of easy-to-see responses on item Q9C for older respondents.

Table 26. Statistically significant model parameters for predicting “easy” to see responses in four visibility scenarios (older age group)

Direction of influence for significant parameters in logistic regression models	Having HID headlamps	Having headlamps with a sharp cut-off beam pattern	Having headlamps with projector optics
Q9A – On curved roads, how easy is it for you to see lane lines using your low beams?	+	NS	NS
	($p < .05$)	($p = .17$)	($p = .98$)
Q9B – How easy is it for you to read overhead road signs that are not lighted except by your headlights’ low beams?	+	+	NS
	($p < .05$)	($p < .10$)	($p = .82$)
Q9C – On roads without street lights, how easy is it for you to see pedestrians on or near the road using your low beams?	+	NS	-
	($p < .10$)	($p = .17$)	($p < .05$)
Q9D – When you approach a hill how easy is it for you to see the roadway up the hill ahead using your low beams?	NS	NS	NS
	($p = .29$)	($p = .83$)	($p = .91$)

Table 27. Statistically significant model parameters for predicting “easy” to see responses in four visibility scenarios (younger age group)

Direction of influence for significant parameters in regression model	Having HID headlamps	Having headlamps with a sharp cut-off beam pattern	Having headlamps with projector optics
Q9A – On curved roads, how easy is it for you to see lane lines using your low beams?	NS ($p = .82$)	+	NS ($p = .30$)
Q9B – How easy is it for you to read overhead road signs that are not lighted except by your headlights’ low beams?	NS ($p = .81$)	NS ($p = .84$)	NS ($p = .30$)
Q9C – On roads without street lights, how easy is it for you to see pedestrians on or near the road using your low beams?	+	+	NS ($p = .20$)
Q9D – When you approach a hill how easy is it for you to see the roadway up the hill ahead using your low beams?	NS ($p = .62$)	NS ($p = .11$)	NS ($p = .55$)

9. Safety

Perceived safety of HID headlamps

“I feel much more confident driving with the HID lights. I feel safer at highway speed; you do not seem to be out driving your lights like you do with conventional halogen lights.” (Male, 35)

“The lights are great for me at the expense of other drivers. I can see way down the road with them however I’m concerned about my safety, I’ve heard about road rage for far less. I finally had a dealer jury-rig an adjustment with shims to lower the beam somewhat because of the constant flashing by other drivers.” (Male, 81)

Owners of HID headlamps were asked, “Overall, does having your HID or adaptive headlights make you a safer driver than if you had conventional headlights?” (Q23). The majority of respondents (56.6%) thought their advanced headlamps did make them safer drivers, and 42.5 percent said, “Neither more nor less safe.” Less than one percent felt having HID headlamps made them less safe. Differences between older and younger respondents to this question were not statistically significant, $\chi^2(2) = 4.4, p = .11$.

Some differences were noted between vehicle manufacturers in the proportion of respondents who said their headlamps make them safer. For analysis purposes, the response frequencies were combined for those who said, “Neither more nor less safe” with those who said “less safe” and the results were compared to the number of respondents who said, “Safer.” These results are shown in Table 28. The proportion of respondents who said having HID headlamps makes them safer as drivers depended significantly on vehicle manufacturer, $\chi^2(5) = 13.2, p < .05$. BMW owners and Mercedes-Benz owners had the highest proportion of respondents who thought having HID headlamps made them safer drivers.

Table 28. Overall, does having your HID and/or adaptive headlights make you a safer driver than if you had conventional headlights? By vehicle manufacturer

Frequency (Col. Pct.)	Acura	Audi	BMW	Mercedes-Benz	Nissan	Toyota	Total
Safer	237 (53.14)	26 (60.47)	75 (68.81)	23 (67.65)	121 (51.27)	16 (51.61)	498 (55.39)
Neither more nor less safe (or) Less safe	209 (46.86)	17 (39.53)	34 (31.19)	11 (32.35)	115 (48.73)	15 (48.39)	401 (44.61)
Total	446	43	109	34	236	31	899
Row Pct.	49.61	4.78	12.12	3.78	26.25	3.45	100.00

Experience with collisions and near collisions due to headlamp glare

As discussed above in the section on headlamp glare, none of the respondents to this survey reported that in the last six months light from oncoming vehicles or light from a vehicle behind them had caused them to unintentionally drive off the road. Three people (0.14%) reported that they had a crash or close call as a result of light from oncoming vehicles, and none reported having a crash or close call as a result of light from a vehicle behind.

10. Need for Improvements to Headlamps

All respondents were asked whether there is anything about their headlights that should be improved (Q20). The responses to this item did not depend significantly on whether or not the respondents owned HID headlamps, $\chi^2(1) = 2.2, p = .13$, nor did they depend significantly on age group, $\chi^2(1) = 1.1, p = .30$. Overall, respondents were satisfied with their headlamps. Only 14 percent saw a need for improvements. A list of the most requested improvements is shown in Appendix B. The three most frequently suggested concepts were, “provide wider coverage of headlights,” “improve beam to reduce effect on other drivers,” and “increase automation of headlamps, such as lights that automatically change based on traffic and weather conditions.”

Among respondents who own HID headlamps, the responses to this question depended significantly on vehicle manufacturer, $\chi^2(1) = 11.2, p < .05$. As shown in Table 29, BMW and Mercedes-Benz owners were least likely to say their headlamps should be improved.

Table 29. Is there anything about your headlights you think should be improved? (Q20) By vehicle manufacturer

Frequency (Col. Pct.)	Acura	Audi	BMW	Mercedes-Benz	Nissan	Toyota	Total
Yes	54 (14.63)	11 (28.21)	7 (7.37)	2 (7.14)	29 (14.29)	4 (15.38)	107 (14.08)
No	315 (85.37)	28 (71.79)	88 (92.63)	26 (92.86)	174 (85.71)	22 (84.62)	653 (85.92)
Total	369	39	95	28	203	26	760
Row Pct.	48.55	5.13	12.50	3.68	26.71	3.42	100.00

11. Meeting the Needs of Older Drivers

Item Q24 asked respondents, “In general, do you believe that car manufacturers are doing enough to design their vehicles to accommodate an aging population?” Nearly 20 percent of all respondents said, “No,” and approximately 45 percent said they didn’t know.

Approximately 36 percent of both younger and older respondents said “yes” to this question. Small differences were observed between the age groups in the proportions of “No” and “Don’t know” responses, but overall, differences between the age groups failed to reach the $\alpha = .05$ level of significance, $\chi^2(2) = 5.6, p = .06$. No statistically significant differences in responses to this question were observed between vehicle manufacturers, $\chi^2(10) = 14.7, p = .14$, but the responses were significantly different for HID headlamp owners as compared to non-HID headlamp owners, $\chi^2(2) = 15.2, p < .001$. These results are shown in Table 30. HID headlamp owners were more likely to say, “Yes” or “Don’t know,” and less likely to say, “No” as compared to non-HID headlamp owners.

Table 30. In general, do you believe car manufacturers are doing enough to design their vehicles to accommodate an aging population? (Q24) By headlamp type

Frequency (Col. Pct.)	HID	No HID	Total
Yes	404 (37.58)	138 (34.50)	542 (36.75)
No	183 (17.02)	104 (26.00)	287 (19.46)
Don’t Know	488 (45.40)	158 (39.50)	646 (43.80)
Total	1075	400	1475
Row Pct.	72.88	27.12	100.00

Respondents who answered, “No” to this question were asked to make suggestions about what else they believed could be done. A list of the most common suggestions is shown in Appendix B. During the follow-up telephone interviews, respondents were asked whether

vehicle manufacturers were doing enough to design vehicles for aging drivers. Five of these responses are given below:

“The luxury brands of cars are getting more electronic technology each day and certain manufactures control systems like the BMW ‘I Drive’ and the Mercedes Benz touch screen system are becoming overly complex to use. They need more intuitive control systems for seniors.” (Male, 73)

“Yes, I think they are doing OK.” (Male, 33)

“No! I think the manufacturers are too busy trying to target younger drivers. They don't have health problems to deal with. Glare is a real problem with middle age and older drivers. You can't see out of the back of the cars and they have way too many blind spots. The slanted windshields contribute to glare. The driver seats need to be higher and more upright.” (Female, 80)

“That’s a tough question, HID lights are great for me but I understand seniors have big problems coping with the bluish light they generate. More cars are being produced with electronic nannies like accident avoidance and lane change warning systems, etc. that should help, unfortunately they are on high-cost cars now.” (Male, 38)

“I think the manufacturers are doing enough with all the new safety technology. The new technology is a real feather in their cap.” (Male, 69)

The complete set of responses from the telephone interviews is given in Appendix D.

SUMMARY AND DISCUSSION

Summary of Findings

Questionnaires were mailed to vehicle owners who may have HID headlamps or adaptive headlamps in an effort to understand how these technologies are influencing driver behavior and to assess the extent to which early adopters of these systems understand the systems' performance capabilities and limitations.

Survey samples

Approximately 21 percent of the headlamp questionnaires were returned from a mail-out survey to 10,000 ACSC insurance customers who were identified as owning vehicle models likely to have HID headlamps or directionally adaptive headlamps. Half of the questionnaires were mailed to vehicle owners who were younger than 65 and half of the questionnaires were mailed to owners who were 65 years or older. Based on respondents' self-reports and based on the known equipment on their vehicle models (and model years), 1081 respondents had HID headlamps but only 19 respondents had adaptive headlamps.

Uncertainty regarding headlamp type

A large percentage of respondents didn't know what type of headlamps was on their vehicle.

- 18 percent didn't know whether they had HID headlamps or not.
- 20 percent didn't know whether they had adaptive headlamps or not.
- Older respondents were less likely than younger respondents to know what headlamp type they had.
- Women were less likely than men to know what type of headlamps they had.

Although the questionnaire specifically requested that respondents look at their vehicle to answer two of the questions about their headlamp type,

- 24 percent didn't know whether their headlamp lens was similar to the projector optic shown in a picture on the questionnaire.
- 31 percent didn't know whether the projected beam pattern from their headlamps had a sharp cut-off on top or a fuzzy cut-off as illustrated in the questionnaire.

Desire to have HID and adaptive headlamp technologies

A large majority of those who currently have HID headlamps (88%) said if they purchased their same vehicle again, they would want to get the technology again, and 75 percent agreed that, "I prefer my headlights to conventional headlights." Only 23 percent of respondents without HID headlights said they would want to get them.

The most common reasons cited for not purchasing HID headlights (and adaptive headlights) were related to availability of the technology and lack of knowledge about the technology. Cost was cited as a reason for not having advanced headlamp technology by only 7 percent of those who did not purchase HID headlamps, and by 2.8 percent of respondents who did not purchase adaptive headlamps.

Behavioral adaptation

- Younger drivers reported driving much more frequently while it was dark outside as compared to older drivers. However, for younger drivers and for older drivers, the reported frequency of driving while it was dark outside did not depend significantly on whether the respondent had HID headlamps or not. Thus, there was no evidence having HID headlamps increased the frequency of driving at night. However, when respondents were asked directly, 40 percent of those with HID headlamps agreed with the statement that, “I am more willing to drive at night with my headlights than with conventional headlights.”
- When asked, “If your headlight system had to be replaced with conventional headlights, how would your driving behavior change?” approximately 70 percent of those with HID headlamps said their behavior would not change, perhaps indicating these respondents don’t notice any difference in the way they drive with HID headlamps versus conventional headlamps.
- Nearly 18 percent said they would drive more slowly at night with conventional headlamps than they do now with their HID headlamps. Some would limit where or when they drive, by avoiding unfamiliar places at night (10%), avoiding dark roads (11%), or limiting the amount of nighttime driving (9%) if they had conventional headlamps.

Despite the fact that 70 percent of respondents with HID headlamps indicated on another question their driving behavior would not change if their HID headlamps were replaced by conventional headlamps, many respondents seemed to acknowledge their driving behavior had changed in some specific ways as a result of getting HID headlamps. The percentage of respondents with HID headlamps who agreed or strongly agreed with each statement is given below:

- 58 percent - “I use the high beams less often than I would if I had conventional headlights,” (Q22A). Younger respondents were more likely than older respondents to strongly agree with the statement.
- 40 percent – “I am more willing to drive at night with my headlights than with conventional headlights,” (Q22C). Younger respondents were more likely than older respondents to strongly agree with the statement.
- 23 percent – “I am willing to drive faster using my headlights’ low beams than with the low beams from conventional headlights,” (Q22D). Responses to this item did not depend significantly on age group.

Perceived effectiveness of headlamps

HID headlamp owners tended to prefer their headlamps to conventional headlamps and they tended to agree they experienced less eye strain with HID headlamps than with conventional headlamps. The percentage of respondents with HID headlamps who agreed or strongly agreed with each of the following statements (from item Q22) is given below:

- 75 percent - “I prefer my headlights to conventional headlights,” (Q22E).
- 61 percent – “I feel less eyestrain driving at night with my headlights than with conventional headlights,” (Q22B).

- Younger owners of HID headlamps were more likely than older owners to strongly agree with each of the two statements above.

Perceived effectiveness of headlamps also was assessed by asking all respondents how well they could see while driving at night under four different scenarios. Respondents with HID headlamps were more likely than those without HID headlamps to say it is “Easy” (or “Very Easy”) for them to see in each of the four scenarios described in items Q9A to Q9D.

- Q9A – On curved roads, how easy is it for you to see lane lines using your low beams?
- Q9B – How easy is it for you to read overhead road signs that are not lighted except by your headlights’ low beams?
- Q9C – On roads without street lights, how easy is it for you to see pedestrians on or near the road using your low beams?
- Q9D – When you approach a hill how easy is it for you to see the roadway up the hill ahead using your low beams?

Logistic regression analyses were used to investigate the combined influence of several possible predictive variables on whether respondents said seeing was “easy” (very or somewhat) in the four visibility scenarios (Q9A-Q9D). Age group was an important predictor of easy-to-see responses; younger respondents were more likely to say “easy” than were older participants when controlling for headlamp type, beam pattern, and headlamp optics type.

For older respondents, having HID headlamps was associated with “easier” reported seeing in scenarios Q9A – Q9C. Having projector optics was associated with fewer easy-to-see responses for scenario Q9C.

For younger respondents, having HID headlamps was associated with easy-to-see responses for scenario Q9C (pedestrians), but not for the other three scenarios. Having a sharp cut-off beam pattern was associated with easy-to-see responses for scenarios Q9A and Q9C.

Safety and headlamp glare

- The majority of HID headlamp owners (56.6%) believe they are safer drivers with HID headlamps they would be if they had conventional headlamps.
- BMW owners and Mercedes-Benz owners had the highest proportion of respondents who thought having HID headlamps made them safer drivers.
- None of the respondents reported in the last six months light from oncoming vehicles had caused them to unintentionally drive off the road, but three respondents (0.14%) reported they had a crash or close call as a result of light from oncoming vehicles. None of the respondents reported having a crash or close call as a result of light from a vehicle behind.
- Approximately 29 percent of the respondents said that in the last six months, while driving at night, the light from oncoming vehicles generally has been, “Annoying,” and six percent said it has been, “Blinding/disturbing.” Approximately 26 percent of respondents found the light from vehicles behind them to be, “Annoying,” and five percent of respondents said it has been, “Blinding/disturbing.”

Headlamp glare may be particularly bad for oncoming drivers when headlamps misaligned. Overall, only 14 percent of respondents said they ever had the aim of the headlamps on their current vehicles checked or adjusted. The proportion of respondents who had done this was the same among HID headlamp owners and among those without HID headlamps. Among those who had their headlamp aim checked, approximately 19 percent said they did so because they were concerned about causing glare or distraction to other drivers. The percentage of respondents who said this was not significantly different between HID headlamp owners and non-HID headlamp owners. Only 9 percent of respondents who had their headlamps checked said a reason for doing so was, “Oncoming vehicles kept flashing their headlights at me.” The proportion of respondents citing this reason was not significantly different for HID headlamp owners as compared to non-HID headlamp owners.

Logistic regression analyses showed that when controlling for age group, gender, beam pattern, and headlamp optics, headlamp type (HID or non-HID) was a significant predictor of whether respondents reported receiving high-beam flashes from other drivers.

A second logistic regression model included headlamp type (HID or non-HID), vehicle manufacturer (Acura, Audi, BMW, Mercedes-Benz, Nissan, and Toyota), age group, gender, and an intercept parameter. In this analysis, only headlamp type (HID versus non-HID) was a statistically significant predictor of reporting high-beam flashes from other drivers.

Need for headlamp improvements and vehicle improvements

- Overall, most HID headlamp owners and non-HID headlamp owners were satisfied with their headlamps. Only 14 percent saw a need for improvements, and there was no significant difference between those with and without HID headlamps. The three most frequently suggested improvements were, “provide wider coverage of headlights,” “improve beam to reduce effect on other drivers,” and “increase automation of headlamps, such as lights that automatically change based on traffic and weather conditions.”
- Approximately 36 percent of survey respondents thought that vehicle manufacturers are doing enough to design vehicles to accommodate an aging population. Approximately 20 percent said, “No” (that vehicle manufacturers were not doing enough), and 44 percent said they didn’t know. Younger and older respondents did not differ significantly in their responses.

Summary of differences by age group

Older respondents were less likely than younger respondents to have HID headlamps on their vehicles, however, this difference may be partly attributed to the fact that older respondents were less likely than younger respondents to know whether they had HID headlamps on their vehicles. Several other differences between age groups are described below.

- The distribution of respondents across by vehicle manufacturer differed by age group. For example, older respondents were more likely than younger respondents to own vehicles manufactured by Toyota or BMW, and younger respondents were more likely to have vehicles manufactured by Audi or Acura.

- Older respondents (median = 20,000 miles) tended to have less experience driving their current vehicle as compared to younger respondents (median = 25,000 miles). Older respondents also reported driving while it was dark outside much less frequently than younger respondents.

When older and younger respondents were compared in terms of vision conditions, older respondents were more likely to report

- wearing glasses while driving at night;
- having cataract surgery;
- currently having cataracts; and
- having other vision conditions.

Younger respondents were more likely to report

- wearing contact lenses while driving at night;
- having Lasik surgery; and
- having none of the vision conditions listed.

Older and younger respondents' perception of light (glare) from oncoming vehicles was similar as was their assessment of light from vehicles behind. Older respondents who have HID headlamps were more likely to find light from oncoming vehicles acceptable as compared to older respondents without HID headlamps.

When responding to light from oncoming vehicles, older respondents were

- less likely than younger respondents to block the light with their hands;
- more likely to limit their driving at night; and
- more likely to avoid driving on unlighted two-lane roads.

When responding to light from vehicles behind, older respondents were

- less likely than younger respondents to block the light with their hands;
- less likely to move their head or eyes away from the light reflected by the mirrors; and
- more likely than younger respondents to limit their driving at night.

Among respondents who have HID headlamps, younger respondents were more likely than older respondents to strongly agree with the following statements:

- "I use the high beams less often than I would if I had conventional headlights";
- "I feel less eyestrain driving at night with my headlights than with conventional headlights";
- "I am more willing to drive at night with my headlights than with conventional headlights"; and
- "I prefer my headlights to conventional headlights."

The proportion of respondents who agreed versus disagreed with the statement, “I am willing to drive faster using my headlights’ low beams than with the low beams from conventional headlights,” did not differ significantly between age groups.

The proportion of respondents with HID headlamps who felt that the headlamps made them safer drivers did not differ significantly between younger and older age groups.

Study Limitations

The survey methodology used in this study was an efficient way to assess a large number of drivers’ perceptions about headlamp technologies. It provided insights into drivers’ understanding of the functional capabilities of the systems and it was also effective at providing some information about how the systems may be affecting driver behavior. Given the various limitations of the method explained below, however, the results provided by this work should be confirmed by observational studies and experimental methods.

- Self-reports were obtained from questionnaires mailed to a random sample of ACSC members who were likely system owners (based on model of vehicle owned). There are some inherent weaknesses associated with this type of data. Self-reports can be unreliable, especially where respondents need to rely on memories of past events or where respondents may have certain expectancies about giving answers that they believe the researchers “want” to see, for example. Although each questionnaire was mailed to a specific vehicle owner to be answered about a specific vehicle, it is possible that other household members completed some questionnaires or that a respondent answered the questionnaire based on experience with a vehicle other than the one specified.
- Given the relatively high number of respondents who answered, “Don’t know” to questions regarding their type of headlamp technology, headlamp optics, and headlamp beam pattern, it is likely that some of the other respondents answered these questions incorrectly. For example, some respondents who said they had (or did not have) HID headlamps may have been incorrect. Classifications of respondents by headlamp technology, headlamp optics, or beam pattern may be contaminated by such incorrect responses. Assuming that most respondents who answered these questions were correct about their headlamp systems, then a small number of misclassifications would have the effect of diluting any differences in responses between groups. Small response differences between groups could be masked by misclassification, but the observed differences between groups that were found to be statistically significant in the present analyses (with some misclassifications) would likely remain significant if there were no misclassifications.
- In this study, no attempt was made to obtain a nationally representative sample. ACSC members may differ in some ways from other vehicle owners who are not members of an automobile club, or from those who live in different areas of the country with different weather and traffic conditions. The characteristics of the sample obtained should be considered carefully if the results are generalized.
- The response rate for the headlamp survey was approximately 21 percent. This is a fairly high rate for a single-contact mail-out survey of this length without any type of

incentives for respondents. However, the sample may not be representative of ACSC members if those who responded have had different experiences with the technology as compared to those who did not respond. Future studies of this type should attempt to increase the response rate by converting non-responders to responders through methods such as a second or third mailing, through a telephone call, or by offering an incentive to participate.

Implications

- Drivers don't necessarily know what type of headlamps they have. Approximately 18 percent of respondents were not aware of what type of headlamp technology was on their vehicles. This suggests that vehicle owners may need better education about the technology on their vehicles. Further research could determine if the lack of knowledge about headlamps is indicative of a more general lack of knowledge about in-vehicle technologies.
- Among older respondents, the effects of light from oncoming vehicles depended significantly on whether or not the respondents had HID headlamps. Older respondents with HID headlamps were more likely to find light from oncoming vehicles acceptable as compared to older respondents without HID headlamps. Further objective research is needed to determine if and how HID headlamps may be beneficial for improving visibility for older drivers. For example, perhaps HID headlamps simply provide better visibility as the driver recovers from the effects of glare from oncoming vehicles, or perhaps the higher state of light adaptation (or adaptation to shorter wavelengths) induced by driving with brighter, bluer HID headlamps has a protective effect against the glare from other vehicles.
- Checking and adjusting headlamp aim may be especially important for HID headlamp owners who have 30,000 (or more) miles on their vehicles. While driving with low beams on, this group of respondents had the highest probability of receiving high-beam flashes from other drivers which could indicate that the respondents' low beam headlamps are causing excessive glare to oncoming drivers because they are misaligned, or the beam pattern of some HID headlamps may be too glaring even when aimed properly. If it is determined that the primary problem is misalignment, then drivers should be encouraged to have the aim of their headlamps checked periodically.
- Although most respondents did not report differences in their driving behavior with HID headlamps as compared to conventional headlamps, a large minority (40%) of drivers said they are more willing to drive at night with HID headlamps than with conventional headlamps, and nearly a quarter of both older and younger respondents with HID headlamps said they are willing to drive faster with their headlamps as compared to conventional headlamps. It may be that further objective research, including longitudinal research should be undertaken to understand in more detail how drivers modify their behavior as a result of having advanced headlamps.

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APPENDIX A:

MAIL-OUT SURVEY INSTRUMENT AND RECRUITMENT LETTER



1577 So. Valley Vista Drive
Diamond Bar, CA 91765

«First_Name» «Last_Name»
«Address»
«City», «State» «Zip»

Dear Member:

The Automobile Club of Southern California (AAA) is working on a major research project to reduce traffic crashes and injuries on our roadways. We need your help in completing this important study.

The goal of our study is to make recommendations to the automotive industry and government about the kinds of innovative equipment that should be put on vehicles to protect drivers and make our roads safer. The Club selected your name *at random* from the rolls of members who are owners of recent model vehicles.

The car you own is likely to be equipped with the technology we are investigating. As an “early adopter” of this technology, your responses will be very valuable and we would especially like to hear your opinions about your vehicle’s **headlights**. Please take a few minutes to fill out the attached survey and mail it back in its pre-paid envelope.

Please let us know, by filling out the attached questionnaire, about the headlights on your «Model_Yr» «Manufacturer», with Vehicle Identification Number «VIN».

All information you provide is voluntary, strictly *confidential* and will be used *solely* for scientific purposes. (It does not affect your insurance rates or membership and will not be used for marketing purposes.)

Thank you in advance for your help with this project, and its exciting opportunity to influence our next generation of motor vehicles.

Please complete the enclosed survey and return it in the postage paid envelope.

Thank you for your cooperation,

A handwritten signature in black ink, appearing to read "Steven D. Mazor". The signature is written in a cursive style with some loops and flourishes.

Steven D. Mazor
Manager, Automotive Research Center
(909) 612-2560

(OVER)

«Zip»

«Model_Yr» «Manufacturer» «Model_Code» «Age_Code» «Code» «Survey_»

OPTIONAL:

We are planning to follow up this mail survey with some more in-depth telephone interviews of some of the survey respondents. These interviews are expected to take up to 15 minutes. If you would be interested in participating in a follow up interview, please fill in the personal (optional) information below. We will only be contacting a limited number of respondents for follow ups. They will be selected randomly from those who volunteer. Not all volunteers will be contacted.

Would you like to participate in a telephone interview? *(circle one)* Yes No

If yes, please tell us:

Your name (optional) _____

Telephone number _____

Best time(s) of day to reach you at this number? *(circle all that apply)*

Morning Afternoon Evening

Thank you for completing the survey!

Please mail it back in the business reply envelope provided.

Automobile Club of Southern California

1577 So. Valley Vista Drive

Diamond Bar, CA 91765

Please tell us about yourself:

1. Age: ____ (you must be at least 18 years of age to participate)

2. Gender (circle one) Male Female

3. Which of the following statements describe your vision?

(check boxes for all that apply)

- I wear glasses when driving at night
- I wear contact lenses when driving at night
- I had Lasik surgery
- I had cataract surgery
- I currently have cataracts
- I have another vision condition (explain): _____
- None of the above

4. Approximately how many miles have you personally driven this vehicle? _____ miles

5. Did you test drive the vehicle at night prior to purchasing it? (circle one) Yes No

6. Have you ever had the aim of your headlights checked or adjusted on this vehicle? (circle one) Yes No

If yes, why? (check boxes for all that apply)

- State inspection requirement
- The service was offered during maintenance
- I was concerned about causing glare or distraction to other drivers
- Oncoming vehicles kept flashing their headlights at me
- I couldn't see well
- I was required to have it checked/adjusted because I was stopped by law enforcement

(OVER)

7. During the winter months, how often do you drive when it is dark outside?
(circle one)

- Never or almost never 1
- Less than once a week..... 2
- One or two times a week..... 3
- Three or four times a week..... 4
- Five or more times a week 5

8. When you drive at night, how often do other drivers flash their high beams at you, even though you have your low beams on?
(circle one)

- Never or almost never 1
- Occasionally 2
- Frequently 3
- Every time or nearly every time I drive at night 4

9. How easy is it for you to see each of the following while driving at night?
(circle one response for each row)

	Very Easy	Somewhat Easy	Somewhat Difficult	Very Difficult	Don't Know
On curved roads, how easy is it for you to see lane lines using your low beams?	1	2	3	4	5
How easy is it for you to read overhead road signs that are not lighted except by your headlights' low beams?	1	2	3	4	5
On roads without street lights, how easy is it for you to see pedestrians on or near the road using your low beams?	1	2	3	4	5
When you <u>approach</u> a hill how easy is it for you to see the roadway up the hill ahead using your low beams?	1	2	3	4	5

10. In the last six months, while driving at night, the light from oncoming vehicles generally has been: *(circle one)*

- Blinding/Disturbing 1
- Annoying..... 2
- Acceptable..... 3

11. In the last six months, the light from oncoming vehicles has caused me to: *(check boxes for all that apply)*

- Block the light with my hands
- Look to the right side of the roadway, away from the roadway directly ahead
- Slow down or stop until the oncoming light has passed
- Unintentionally drive off the edge of the road
- Have a crash or a close call
- Limit the amount of driving that I do at night.....
- Avoid driving on unlighted two-lane roads
- None of the above

12. In the last six months, while driving at night, the light from vehicles behind me generally has been: *(circle one)*

- Blinding / Disturbing 1
- Annoying..... 2
- Acceptable..... 3

13. In the last six months, while driving at night, the light from vehicles behind me has caused me to: *(check boxes for all that apply)*

- Block the light with my hands
- Move my head or eyes away from the light reflected from my mirrors .
- Turn the inside rear-view mirror to the “dim” position, or move the mirror itself
- Slow down or stop until the vehicle has passed, or turned off the road..
- Unintentionally drive off the edge of the road
- Have a crash or a close call
- Limit the amount of driving that I do at night.....
- None of the above

(OVER)

Please look at your vehicle's headlights to answer the following two questions.

14. Is your low beam headlight small and round, with an opaque lens (that you can't see through) similar to the one shown by the arrow?

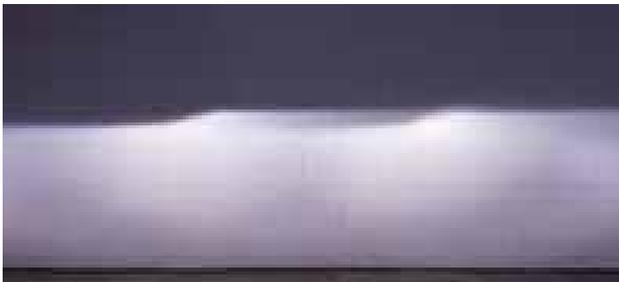
(circle one) Yes No Don't Know



15. Which photo below looks more like the light pattern your headlights would project on a wall?

(circle one) A B Don't Know

A – Headlights produce a sharp, distinct cut-off (line) between the light area below and the dark area near the top of the picture.



B – Headlights produce a fuzzy, less distinct cut-off (line) between the lighter area below and the darker area near the top of the picture.



The next few questions (Questions #16 through #19) ask about two new headlight technologies. We would like to know if your vehicle has one, both, or neither of these technologies.

16. High-Intensity Discharge (HID) (sometimes called Xenon headlights) - HID headlights appear slightly bluish-white as compared to the yellowish-white light of conventional Halogen headlights.

Does your vehicle have HID or Xenon headlights?

(circle one) Yes No Don't Know

If no, then why didn't you choose to get a vehicle with HID headlights?

(check boxes for all that apply)

- It never occurred to me to look for this option
- They were not an option on my vehicle
- I thought they would be a nuisance or distraction to other drivers.....
- I don't need them because I can see well at night without them.....
- They were not worth the extra cost
- They were only available with other options that I didn't want
- I was not the person who purchased or made the decision to purchase this vehicle

17. If you purchased this same model vehicle again, would you want HID headlights?

(circle one) Yes No Don't Know

(OVER)

18. Adaptive (or “active”) headlights can automatically change the direction of the light beam when you steer left or right on curved roads. On your vehicle, these headlights may be called “steerable headlights” or something similar.

Does your vehicle have adaptive (or “active”) headlights?

(circle one) Yes No Don’t know

If no, then why didn’t you choose to get a vehicle with adaptive headlights?

(check boxes for all that apply)

- It never occurred to me to look for this option
- Adaptive headlights were not an option on my vehicle
- I thought those headlights would be a nuisance or distraction to other drivers
- I didn’t trust adaptive headlights.....
- I didn’t need adaptive headlights because I am a good driver
- Adaptive headlights were not worth the extra cost
- Adaptive headlights were only available with other options I didn’t want
- I was not the person who purchased or made the decision to purchase this vehicle

19. If you purchased this same model vehicle again, would you want adaptive headlights?

(circle one) Yes No Don’t Know

20. Is there anything about your headlights that you think should be improved?

(circle one) Yes No

If yes, please explain:

If you have HID headlights and/or adaptive headlights, please continue with question 21

If you do not have either of these headlight types, please **skip** to question → 24



21. If your headlight system had to be replaced with conventional headlights, how would your driving behavior change? *(check boxes for all that apply)*

- I would limit my night driving more than I do now.....
- I would avoid going to unfamiliar places at night more than I do now ..
- I would avoid dark roads more than I do now
- I would drive more slowly at night than I do now
- My driving behavior would not change
- Other (*specify*): _____

22. Please indicate how much you agree or disagree with the following statements. *(circle one response for each row)*

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I use the high beams <u>less</u> often than I would if I had conventional headlights.	1	2	3	4	5
I feel <u>less</u> eye strain driving at night with my headlights than with conventional headlights.	1	2	3	4	5
I am <u>more</u> willing to drive at night with my headlights than with conventional headlights.	1	2	3	4	5
I am willing to drive faster using my headlights' low beams than with the low beams from conventional headlights.	1	2	3	4	5
I prefer my headlights to conventional headlights	1	2	3	4	5

(OVER)

23. Overall, does having your HID and/or adaptive headlights make you a safer driver than if you had conventional headlights? *(circle one)*

- Safer 1
- Neither more nor less safe..... 2
- Less safe..... 3

24. In general, do you believe that car manufacturers are doing enough to design their vehicles to accommodate an aging population?

(circle one) Yes No Don't Know

If you answered “no” then what more do you believe could be done?

(Explain): _____

Thank you for completing the survey!

Please mail it back in the business reply envelope provided.

*Automobile Club of Southern California
1577 So. Valley Vista Drive
Diamond Bar, CA 91765*

APPENDIX B: TABULATED SURVEY RESULTS FOR HEADLAMP SURVEY

The following list shows the response frequencies for each item on the headlamp survey. Counts shown are the number of respondents who selected a particular response. Note that some items on the questionnaire required the respondent to choose a single best response, while other items required the respondent to indicate all responses that apply. The responses to open-ended questions (write-in responses) have been coded into categories. Of the 10,000 questionnaires mailed out, 2,126 questionnaires were returned within three months and were included in the analyses. For each item, the response percentages shown are calculated based on a total count of responses, a sub-total count of valid responses, or the total number of respondents depending on which measure researchers believe is most appropriate for understanding the pattern of results. For items on which the participant was able to make multiple responses, percentages are based on the total number of respondents who selected at least one response to that question. For items where open-ended responses were solicited, the responses were read by data coding staff and classified into a small number of post-hoc categories. These categories are shown in *italics* in the response descriptions below.

Model year of vehicle					
Description	Count	Percentage	Count with HID	Percentage with HID	
2001	320	15.05	173	15.49	
2002	352	16.56	175	15.67	
2003	348	16.37	174	15.58	
2004	731	34.38	380	34.02	
2005	362	17.03	208	18.62	
2006	13	0.61	7	0.63	
Total	2,126	100.00	1,117	100.00	

Vehicle manufacturer

Description	Count	Percentage	Count with HID	Percentage with HID
Acura	713	33.54	470	42.08
Audi	74	3.48	46	4.12
BMW	185	8.70	117	10.47
Cadillac	122	5.74	23	2.06
Chevrolet	10	0.47	9	0.81
Chrysler	33	1.55	18	1.61
Ford	1	0.05	1	0.09
Honda	61	2.87	48	4.30
Mazda	5	0.24	0	0.00
Mercedes-Benz	197	9.27	38	3.40
Mini	25	1.18	11	0.98
Mitsubishi	8	0.38	6	0.54
Nissan	477	22.44	259	23.19
Porsche	3	0.14	3	0.27
SAAB	5	0.24	2	0.18
Subaru	3	0.14	2	0.18
Toyota	137	6.44	35	3.13
Volkswagen	14	0.66	5	0.45
Volvo	53	2.49	24	2.15
Total	2,126	100.00	1,117	100.00

Q1. Age (self-reported)

Description	Count	Percentage	Count with HID	Percentage with HID
18 - 34 years	225	10.80	163	14.66
35 - 44 years	305	14.64	214	19.24
45 - 54 years	310	14.89	195	17.54
55 - 64 years	288	15.31	175	15.74
65 - 74 years	524	23.67	219	19.69
75 years or older	431	20.69	146	13.13
Subtotal Valid Responses	2,083	100.00	1,112	100.00
Not Ascertained	43		5	
Total	2,126		1,117	

Q2. Gender

Category	Description	Count	Percentage	Count with HID	Percentage with HID
1	Male	1338	64.11	755	68.14
2	Female	749	35.89	353	31.86
	Subtotal Valid Responses	2,087	100.00	1,108	100.00
9	Not Ascertained	39		9	
	Total	2,126		1,117	

Q3. Do you have any vision conditions which make driving more difficult?

Category	Description	Count	Percentage	Count with HID	Percentage with HID
1	I wear glasses when driving at night	1,063	50.64	530	47.88
2	I wear contact lenses when driving	228	10.86	145	13.10
3	I had Lasik surgery	150	7.15	93	8.40
4	I had cataract surgery	245	11.67	96	8.67
5	I currently have cataracts	52	2.48	24	2.17
6	I have another vision condition	79	3.76	28	2.53
7	None	609	29.01	353	31.89
	Subtotal Valid Responses	2,426		1,269	
	Total Respondents	2,099	100.00	1,107	100.00
9	Not Ascertained	27		10	

Q3a. Other physical condition (explain).

Category	Description	Count	Percentage	Count with HID	Percentage with HID
1	Nearsighted/Farsighted/Wears Glasses	46	58.23	20	71.43
2	Macular Degeneration	10	12.66	2	7.14
3	Glaucoma	11	13.92	1	3.57
4	Diabetic Retinopathy (diabetes)	1	1.27	0	0.00
5	RP/Retinitis Pigmentosa /Tunnel Vision	0	0.00	0	0.00
6	Color Blind	0	0.00	0	0.00
94	Other	8	10.13	4	14.29
	Subtotal Valid Responses	76		27	
	Total respondents who responded "other" in Q3.	79	100.00	28	100.00
95	Response did not pertain to the question	2	2.53	1	3.57
96	Text response not reported	1	1.27	0	0.00

Q4. Approximately how many miles have you personally driven this vehicle?

Category	Description	Count	Percentage	Count with HID	Percentage with HID
1	(< 5,000 miles)	150	7.43	69	6.38
2	(5,000 to 9,999)	204	10.10	108	9.99
3	(10,000 to 19,999)	472	23.38	260	24.05
4	(20,000 to 29,999)	423	20.95	217	20.07
5	(30,000 to 39,999)	301	14.91	171	15.82
6	(40,000 to 49,999)	176	8.72	97	8.97
7	(50,000 +)	293	14.51	159	14.71
	Subtotal Valid Responses	2,019	100.00	1,081	100.00
	Not Ascertained	107		36	
9	Total	2,126		1,117	

Q5. Did you test drive the vehicle at night prior to purchasing it?

Category	Description	Count	Percentage	Count with HID	Percentage with HID
1	Yes	373	17.70	232	20.86
2	No	1,734	82.30	880	79.14
	Subtotal Valid Responses	2,107	100.00	1,112	100.00
9	Not Ascertained	19		5	
	Total	2,126		1,117	

Q6. Have you ever had the aim of your headlights checked or adjusted on this vehicle?

Category	Description	Count	Percentage	Count with HID	Percentage with HID
1	Yes	279	13.26	154	13.85
2	No	1,823	86.64	958	86.15
	Don't know (written on form)	2	0.10	0	0.00
	Subtotal Valid Responses	2,104	100.00	1,112	100.00
9	Not Ascertained	22		5	
	Total	2,126		1,117	

Q6a. If yes, why.

Category	Description	Count	Percentage	Count with HID	Percentage with HID
1	<i>State inspection requirement</i>	4	1.43	2	1.29
2	<i>The service was offered during maintenance</i>	224	80.29	112	72.73
3	<i>I was concerned about causing glare or distraction to other drivers</i>	52	18.64	34	22.08
4	<i>Oncoming vehicles kept flashing their headlights at me</i>	25	8.96	15	9.74
5	<i>I couldn't see well</i>	19	6.81	9	5.84
6	<i>I was required to have it checked/adjusted because I was stopped by law enforcement</i>	0	0.00	0	0.00
	Subtotal Valid Responses	324		172	
	Total respondents who answered "yes" to Q6.	279	100.00	154	100.00

Q7. During the winter months, how often do you drive when it is dark outside?

Category	Description	Count	Percentage	Count with HID	Percentage with HID
1	Never or almost never	84	4.09	30	2.76
2	Less than once a week	177	8.61	71	6.54
3	One or two times a week	443	21.56	222	20.46
4	Three or four times a week	496	24.14	252	23.23
5	Five or more times a week	855	41.61	510	47.00
	Subtotal Valid Responses	2,055	100.00	1,085	100.00
9	Not Ascertained	71		32	
	Total	2,126		1,117	

Q8. When you drive at night, how often do other drivers flash their high beams at you, even though you have your low beams on?

Category	Description	Count	Percentage	Count with HID	Percentage with HID
1	Never or almost never	1,723	84.05	889	81.86
2	Occasionally	291	14.20	177	16.30
3	Frequently	30	1.46	16	1.47
4	Every time or nearly every time I drive at night	6	0.29	4	0.37
	Subtotal Valid Responses	2,050	100.00	1,086	100.00
9	Not Ascertained	76		31	
	Total	2,126		1,117	

Q9. How easy is it for you to see each of the following while driving at night?

Q9a. On curved roads, how easy is it for you to see lane lines using your low beams?

Category	Description	Count	Percentage	Count with HID	Percentage with HID
1	Very Easy	1,199	58.75	726	67.04
2	Somewhat Easy	611	29.94	278	25.67
3	Somewhat Difficult	155	7.59	54	4.99
4	Very Difficult	22	1.08	7	0.65
5	Don't Know (written on form)	54	2.65	18	1.66
	Subtotal Valid Responses	2,041	100.00	1,083	100.00
9	Not Ascertained	85		34	
	Total	2,126		1,117	

Q9b. How easy is it for you to read overhead road signs that are not lighted except by your headlights' low beams?

Category	Description	Count	Percentage	Count with HID	Percentage with HID
1	Very Easy	644	31.66	420	38.89
2	Somewhat Easy	787	38.69	428	39.63
3	Somewhat Difficult	385	18.93	159	14.72
4	Very Difficult	131	6.44	41	3.80
5	Don't know (written on form)	87	4.28	32	2.96
	Subtotal Valid Responses	2,034	100.00	1,080	100.00
9	Not Ascertained	92		37	
	Total	2,126		1,117	

Q9c. On roads without street lights, how easy is it for you to see pedestrians on or near the road using low beams?

Category	Description	Count	Percentage	Count with HID	Percentage with HID
1	Very Easy	682	33.40	453	41.87
2	Somewhat Easy	735	35.99	380	35.12
3	Somewhat Difficult	426	20.86	162	14.97
4	Very Difficult	121	5.93	49	4.53
5	Don't know (written on form)	78	3.82	38	3.51
	Subtotal Valid Responses	2,042	100.00	1,082	100.00
9	Not Ascertained	84		35	
	Total	2,126		1,117	

Q9d. When you approach a hill how easy is it for you to see the roadway up the hill ahead using your low beams?

Category	Description	Count	Percentage	Count with HID	Percentage with HID
1	Very Easy	666	32.65	411	38.02
2	Somewhat Easy	790	38.73	408	37.74
3	Somewhat Difficult	387	18.97	177	16.37
4	Very Difficult	80	3.92	35	3.24
5	Don't Know (written on form)	117	5.74	50	4.63
	Subtotal Valid Responses	2,040	100.00	1,081	100.00
9	Not Ascertained	86		36	
	Total	2,126		1,117	

Q10. In the last six months, while driving at night, the light from oncoming vehicles generally has been:

Category	Description	Count	Percentage	Count with HID	Percentage with HID
1	Blinding/Disturbing	129	6.23	59	5.36
2	Annoying	597	28.83	279	25.34
3	Acceptable	1,345	64.94	763	69.30
	Subtotal Valid Responses	2,071	100.00	1,101	100.00
9	Not Ascertained	55		16	
	Total	2,126		1,117	

Q11. In the last six months, the light from oncoming vehicles has caused me to:

Category	Description	Count	Percentage	Count with HID	Percentage with HID
1	Block the light with my hands	337	16.23	188	17.01
2	Look to the right side of the roadway, away from the roadway directly ahead	695	33.46	375	33.94
3	Slow down or stop until the oncoming light has passed	149	7.17	69	6.24
4	Unintentionally drive off the road	0	0.00	0	0.00
5	Have a crash or close call	3	0.14	1	0.09
6	Limit the amount of driving that I do at night	129	6.21	46	4.16
7	Avoid driving on unlighted two-lane roads	54	2.60	17	1.54
	None	1,149	55.32	638	57.74
	Subtotal Valid Responses	2,516		1,334	
	Total respondents	2,077	100.00	1,105	100.00

Q12. In the last six months, while driving at night, the light from vehicles behind me generally has been:

Category	Description	Count	Percentage	Count with HID	Percentage with HID
1	Blinding/disturbing	111	5.37	53	4.82
2	Annoying	529	25.59	264	24.00
3	Acceptable	1,427	69.04	783	71.18
	Subtotal Valid Responses	2,067	100.00	1,100	100.00
9	Not Ascertained	59		17	
	Total	2,126		1,117	

Q13. In the last six months, while driving at night, the light from vehicles behind me has caused me to:

Category	Description	Count	Percentage	Count with HID	Percentage with HID
1	Block the light with my hands	252	12.16	155	14.05
2	Move my head or eyes away from the light reflected from my mirrors	541	26.10	294	26.65
3	Turn the inside rear-view mirror to the "dim" position, or move the mirror it-self	700	33.77	376	34.09
4	Slow down or stop until the vehicle has passed, or turned off the road	49	2.36	25	2.27
5	Unintentionally drive off the road	0	0.00	0	0.00
6	Have a crash or close call	0	0.00	0	0.00
7	Limit the amount of driving that I do at night	72	3.47	26	2.36
	None	1,040	50.17	558	50.59
	Subtotal Valid Responses	2,654		1,434	
	Total respondents	2,073	100.00	1,103	100.00

Q14. Is your low beam headlight small and round, with an opaque lens (that you can't see through) similar to the one shown by the arrow?

Category	Description	Count	Percentage	Count with HID	Percentage with HID
1	Yes	888	45.54	591	56.50
2	No	589	30.21	272	26.00
8	Don't Know	473	24.26	183	17.50
	Subtotal valid responses	1,950	100.00	1,046	100.00
9	Not ascertained	176		71	
	Total	2,126		1,117	

Q15. Which photo looks more like the light pattern your headlights would project on a wall?

Category	Description	Count	Percentage	Count with HID	Percentage with HID
1	A (sharp cut-off beam pattern)	1,093	55.20	699	65.76
2	B (fuzzy beam pattern)	281	14.19	121	11.38
8	Don't Know	606	30.61	243	22.86
	Subtotal Valid Responses	1,980	100.00	1,063	100.00
9	Not Ascertained	146		54	
	Total	2,126		1,117	

Q16. High-Intensity Discharge (HID) (sometimes called Xenon headlights)-HID headlights appear slightly bluish-white as compared to the yellowish-white light of conventional Halogen headlights. Does your vehicle have HID or Xenon headlights?

Category	Description	Count	Percentage
1	Yes	1,126	54.61
2	No	572	27.74
8	Don't Know	364	17.65
	Subtotal Valid Responses	2,062	100.00
9	Not Ascertained	64	
	Total	2,126	

Q16a. If no, then why didn't you choose to get a vehicle with HID headlights.

Category	Description	Count	Percentage
1	<i>It never occurred to me to look for this option</i>	396	69.23
2	<i>They were not an option for my vehicle</i>	233	40.73
3	<i>I thought they would be a nuisance or distraction to other drivers</i>	95	16.61
4	<i>I don't need them because I can see well at night without them</i>	62	10.84
5	<i>They were not worth the extra cost</i>	40	6.99
6	<i>They were only available with other options that I didn't want</i>	24	4.20
7	<i>I was not the person who purchased or made the decision to purchase this vehicle</i>	48	8.39
	Subtotal Valid Responses	898	
	Total Respondents who answered "no" to Q16	572	100.00

Q17. If you purchased this same model vehicle again, would you want HID headlights?

Category	Description	Count	Percentage	Count with HID	Percentage with HID
1	Yes	1,190	58.79	957	87.88
2	No	252	12.45	40	3.67
8	Don't Know	582	28.75	92	8.45
	Subtotal Valid Responses	2,024	100.00	1,089	100.00
9	Not Ascertained	102		28	
	Total	2,126		1,117	

Q18. Adaptive (or "active") headlights can automatically change the direction of the light beam when you steer left or right on curved roads. On your vehicle, these headlights may be called "steerable headlights" or something similar. Does your vehicle have adaptive (or "active") headlights?

Category	Description	Count	Percentage	Count with HID	Percentage with HID
1	Yes	99	4.90	74	6.83
2	No	1,527	75.52	877	80.98
8	Don't Know	396	19.58	132	12.19
	Subtotal Valid Responses	2,022	100.00	1,083	100.00
9	Not Ascertained	104		34	
	Total	2,126		1,117	

Q18a. If no, then why didn't you choose to get a vehicle with adaptive headlights?

Category	Description	Count	Percentage	Count with HID	Percentage with HID
1	<i>It never occurred to me to look for this option</i>	823	53.90	364	41.51
2	<i>They were not an option for my vehicle</i>	965	63.20	618	70.47
3	<i>I thought they would be a nuisance or distraction to other drivers</i>	16	1.05	4	0.46
4	<i>I didn't trust adaptive headlights</i>	16	1.05	8	0.91
5	<i>I didn't need adaptive headlights because I am a good driver</i>	30	1.96	12	1.37
6	<i>Adaptive headlights were not worth the extra cost</i>	43	2.82	24	2.74
7	<i>Adaptive headlights were only available with other options that I didn't want</i>	17	1.11	6	0.68
8	<i>I was not the person who purchased or made the decision to purchase this vehicle</i>	67	4.39	24	2.74
	Subtotal Valid Responses	1,977		1,060	
	Total Respondents Who Answered "No" to Q18	1,527	100.00	877	100.00

Q19. If you purchased this same vehicle model again would you want Adaptive Headlights?

Category	Description	Count	Percentage	Percentage with adaptive headlights (n = 95)	Percentage with HID (n = 1061)
1	Yes	923	46.38	90.53	51.84
2	No	230	11.56	1.05	10.74
8	Don't Know	837	42.06	8.42	37.42
	Subtotal Valid Responses	1,990	100.00	100.00	100.00
9	Not Ascertained	136			
	Total	2,126			

Q20. Is there anything about your headlights that you think should be improved?

Category	Description	Count	Percentage	Count with HID	Percentage with HID
1	Yes	234	14.21	128	14.50
2	No	1,400	85.00	755	85.50
	Subtotal Valid Responses	1,647	100.00	883	100.00
8	Don't Know (written on form)	13	0.79	0	0.00
9	Not Ascertained	479		234	
	Total	2,126		1,117	

Q20a. If yes, please explain.

Category	Description	Count	Percentage	Count with HID	Percentage with HID
1	<i>Improved brightness in adverse weather conditions (fog and rain)</i>	20	7.33	11	8.59
2	<i>Wider coverage of headlights</i>	56	23.93	30	23.43
3	<i>Improve beam to reduce effect on other drivers</i>	51	21.79	34	26.56
4	<i>Need controls for driver to adjust height/angle of beam</i>	24	10.26	15	11.72
5	<i>Increased automation/lights automatically change based on traffic and/or weather conditions</i>	47	20.09	26	20.31
6	<i>Reduced cost for safety features</i>	10	3.66	7	5.47
7	<i>Limited headlight mounting height</i>	6	2.56	3	2.34
94	Other	46	19.66	22	17.19
	Subtotal Valid Responses	260		147	
	Total respondents who responded "yes" to Q20	234	100.00	128	100.00
95	Response did not pertain to the question	19	6.96	10	7.81
96	Text response not reported	5	1.83	1	0.78

(Note: Following the skip pattern specified on the questionnaire, response frequencies for Q21 to Q23 are only for those who have either HID or adaptive headlamps)

Q21. If your headlight system had to be replaced with conventional headlights, how would your driving behavior change?

Category	Description	Count	Percentage
1	I would limit my night driving more than I do now	96	9.19
2	I would avoid going to unfamiliar places at night more than I do now	109	10.43
3	I would avoid dark roads more than I do now	120	11.48
4	I would drive more slowly at night than I do now	185	17.70
5	My driving behavior would not change	735	70.33
6	Other	54	5.17
	Subtotal Valid Responses	1,299	
	Total Respondents who answered Q21	1,045	100.00

Q21a. Other (specify)

Category	Description	Count	Percentage
1	<i>Increased usage of high beams</i>	14	25.93
2	<i>Increased attention while driving</i>	9	16.67
94	<i>Other</i>	11	20.37
	Subtotal Valid Responses	34	
	Total Respondents who answered "other" to Q21.	54	100.00
95	Response did not pertain to question	16	29.63
96	Text response not reported	5	9.26

Q22. For each of the following statements, please indicate how much you agree or disagree.

Q22a. I use the high beams less often than I would if I had conventional headlights.

Category	Description	Count	Percentage
1	Strongly Disagree	88	8.29
2	Disagree	130	12.24
3	Neutral	231	21.75
4	Agree	384	36.16
5	Strongly Agree	229	21.56
	Subtotal Valid Responses	1,062	100.00
9	Not Ascertained	55	
	Total	1,117	

Q22b. I feel less eyestrain driving at night with my headlights than with conventional headlights

Category	Description	Count	Percentage
1	Strongly Disagree	52	4.90
2	Disagree	56	5.28
3	Neutral	306	28.84
4	Agree	403	37.98
5	Strongly Agree	244	23.00
	Subtotal Valid Responses	1,061	100.00
9	Not Ascertained	56	
	Total	1,117	

Q22c. I am more willing to drive at night with my headlights than with conventional headlights.

Category	Description	Count	Percentage
1	Strongly Disagree	76	7.16
2	Disagree	126	11.88
3	Neutral	438	41.28
4	Agree	236	22.24
5	Strongly Agree	185	17.44
	Subtotal Valid Responses	1,061	100.00
9	Not Ascertained	56	
	Total	1,117	

Q22d. I am more willing to drive faster using my headlights' low beams than with the low beams from conventional headlights.

Category	Description	Count	Percentage
1	Strongly Disagree	105	9.91
2	Disagree	254	23.96
3	Neutral	458	42.21
4	Agree	171	16.13
5	Strongly Agree	72	6.79
	Subtotal Valid Responses	1,060	100.00
9	Not Ascertained	57	
	Total	1,117	

Q22e. I prefer my headlights to conventional headlights.

Category	Description	Count	Percentage
1	Strongly Disagree	67	6.33
2	Disagree	41	3.87
3	Neutral	155	14.64
4	Agree	311	29.37
5	Strongly Agree	485	45.80
	Subtotal Valid Responses	1,059	100.00
9	Not Ascertained	58	
	Total	1,117	

Q23. Overall, does having your HID or adaptive headlights make you a safer driver than if you had conventional headlights?

Category	Description	Count	Percentage
1	Yes, Safer	592	56.60
2	Neither More Nor Less Safe	444	42.45
3	No, Less Safe	10	0.96
8	Don't Know (written on form)	0	0.00
	Subtotal Valid Responses	1,046	100.00
9	Not Ascertained	71	
	Total	1,117	

Q24. In general, do you believe that car manufacturers are doing enough to design vehicles to accommodate an aging population?

Category	Description	Count	Percentage
1	Yes	701	35.66
2	No	385	19.58
8	Don't Know	880	44.76
	Subtotal Valid Responses	1,966	100.00
9	Not Ascertained	160	
	Total	2,126	

Q24a. If you answered no, then what more do you believe could be done?

Category	Description	Count	Percentage
1	<i>Improve user interface (displays/controls)/Simplified and larger controls</i>	49	12.73
2	<i>Improved visibilities around vehicle/reducing blind spots/improve mirrors</i>	80	20.78
3	<i>Improved safety features (backing aids)</i>	37	9.61
4	<i>Improved entry/exit access</i>	33	8.57
5	<i>Seating/seatbelt (size and comfort)</i>	42	10.91
6	<i>Reduce cost for safety features</i>	7	1.82
7	<i>Make safety features available on all vehicles (not just high end)</i>	21	5.45
8	<i>Improved gas mileage/other energy conservation</i>	8	2.08
9	<i>Increased automation</i>	23	5.97
10	<i>Minimize pedal confusion</i>	3	0.78
	<i>Reduced headlight glare</i>	35	9.09
94	<i>Other</i>	46	11.95
	Subtotal Valid Responses	384	
	Total respondents who responded "no" to Q24	385	100.00
95	Response did not pertain to question	25	6.49
96	Text response not reported	69	17.83

APPENDIX C: DISCUSSION GUIDE FOR TELEPHONE INTERVIEWS WITH SELECTED RESPONDENTS TO THE HEADLAMP SURVEY

Headlamp Systems

Telephone Interview Discussion Guide

Hello— (introduce yourself, and identify you are from the Automobile Club of Southern California and you are an Automotive Research Specialist in the Club's Automotive Research Center.)

Some time back we sent you a survey about your experience with (Headlights) in your Year/Make/Model. You indicated you would like to participate in our follow-up telephone interviews. This will only take a few minutes, is now a good time, or can you suggest a better time?

On your survey you indicated that the (Headlights) on your car could be improved— read comment from written questionnaire. Probe further into this comment.

Ask if they have any specific examples of when the (Headlights) was particularly helpful or caused a problem.

Have you changed your driving habits as a result of the (Headlights)? If so how? How long did that take?

If they answered no to the last question, "In general, do you believe that car manufacturers are doing enough to design vehicles to accommodate an aging population? Probe into what they think can be done.

APPENDIX D: COMMENTS FROM TELEPHONE INTERVIEWEES

ID #	Age	Gender	Q20 – Improve-ments	Technology - Help-ful/Hurtful?	Change driving hab-its/Comments	Q24 - Mfg's not doing enough	Other ques-tions or con-cerns?
11739	68	M	Would like Xenon headlight for high beams in addition to low beams. Member has HID lights only.	I find the HID lights very helpful, you can see farther around corners since they have a better "spread" and people can see you easier, they notice you. I have had no problems except for the SUVs blasting me from behind, causing me to adjust my mirror to avoid their lights, then I can't see behind me.	I haven't changed my driving habits.	No, they are not doing enough, I have not seen any real examples of them ac-commodating older drivers. However I think the proximity braking I've seen advertised has a real potential for safety. Member commented on cell phone use among other things as being distracting to drivers.	He thought the [Auto] Club was against HID headlights. I explained the purpose of our survey.
20492	47	M	My headlights have a "notch" in them with the driver's side being lower than the passenger side. I would like to get it out; currently my lights will only illuminate the license plate of the car in front of me. [The beams] need to be higher. Member has HID lights only.	The benefits - I can see the sides of the road very clearly; this will allow me to see what's coming from the side better. Also my sister, who can't really see at night with conventional headlights, sees much better with the HID lights. No problems encountered.	I haven't changed my driving habits.	I don't know what they could do, and haven't any idea how much time they have spent on this.	none

ID #	Age	Gender	Q20 – Improve-ments	Technology - Help-ful/Hurtful?	Change driving hab-its/Comments	Q24 - Mfg's not doing enough	Other ques-tions or con-cerns?
16649	49	F	When on a moun-tain road the head-lights shine at un-even lengths and you can't see as far when the road curves left. I would like this corrected. Member has HID lights only	I don't like the head-lights. They have a sharp jagged stair step cut off with the driver's side lower than the passenger side. On mountain roads when the road curves left you can't see very far and must be very careful, I keep the car be-tween the lines and this makes it difficult to see.	Yes, I have changed my driving habits; I have to be a little more cautious since I can't see as far down the road.	Yes, definitely more bells and whistles. They have all the amenities at their finger tips.	none
20483	38	M	I love them, I would like to have them adjustable but the current situation is acceptable. Mem-ber has HID lights only.	I can see the sides of the road better. I haven't had any problems.	I haven't really changed my driving habits.	No, the car manufacturers need to be more aware of the elderly and aging drivers and the cars they drive. They need to look at the suitability of the car and driver.	No, I'm good.
13077	51	F	The brightness has caused oncoming vehicles to flash me when I first pur-chased the used vehicle. I'm getting flashed less as more vehicles have the HID lights. Per-haps drivers are becoming used to the lights. Member has HID lights only.	I find them benefi-cial; especially when pulling into a parking structure, you get a better visual and can see to the sides bet-ter. Problems - driv-ers still flash me sometimes.	I haven't changed my driving habits.	I can't answer that.	none

ID #	Age	Gender	Q20 – Improve-ments	Technology - Help-ful/Hurtful?	Change driving hab-its/Comments	Q24 - Mfg's not doing enough	Other ques-tions or con-cerns?
15111	68	M	I think the lights should be on all the time, I drive country roads & curves in the desert where I live. The lights help other drivers see me in daytime where the sun can be very bright. I would like to have greater range than the lights offer now, even with high beams. Member has HID lights only.	I find them good for me since they are much brighter than my other car and make it easier to see but they are not good for other drivers who have to look at them.	I haven't changed my driving habits. You get used to them over time.	No, they are not doing enough. The dash lights need to be brighter and the gauges easier to read, you can't see them now. I think the vehicle lights should be on 24/7 as soon as you start the car like in Canada. I would like to see heated seats, both bottom and seat backs for passengers, it gets cold in the desert.	none
19218	81	M	The Nissan Maxima headlights can not be adjusted by the dealers. The lights were great for me at the expense of other drivers. I was illuminating signs and the side of the road twenty feet up! Other drivers were constantly flashing me. Went to two dealer service departments about that, wrote and called Nissan and got nowhere! Member stated he was "blown off by Nissan." He even went	The lights are great for me at the expense of other drivers. I can see way down the road with them. However, I'm concerned about my safety. I've heard about road rage for far less. I finally had a dealer jury-rig an adjustment with shims to lower the beam somewhat because of the constant flashing by other drivers.	I drive only when I have to and not for pleasure. I can't say for sure that my driving habits haven't changed.	I feel the industry should standardize on seat belt operation and door latch location for passengers unfamiliar with the vehicle. I feel a lot of the controls for the AC, radio, and other controls should be standardized so that when you rent a vehicle or borrow one you do not have to completely reeducate yourself. Why do controls have to be so "trick"?	none

ID #	Age	Gender	Q20 – Improve-ments	Technology - Help-ful/Hurtful?	Change driving hab-its/Comments	Q24 - Mfg's not doing enough	Other ques-tions or con-cerns?
			to the Highway Pa-trol, again no luck. (xenon lights)				
14369	48	F	The lights create a flat line when re-lected against a wall but don't seem to line up on the road; it looks like something is wrong. Also, I find it hard to see people on the side of the road. They just seem to "pop" into view on the side of the road. That needs im-provement.	I find the lights bene-ficial, everything seems bright and stuff in front of my car is brightly lit. I'm not blinding other drivers since I don't get flashed. Also, I can see pretty far in front of my car. I haven't had any problems.	I don't think I have changed my driving habits. It didn't take any time at all to get used to the lights.	I don't think it's the car manu-facturers but elderly people confusing the gas pedal with the brake. Maybe the auto manufacturers need to add a hand "panic button" [. . .] that slows the car but not sud-denly. I think the real prob-lem is aggressive driving by people who tail gate, weave in etc., and huge vehicles (SUVs and pickup trucks) with drivers who drive way too fast and don't look out for smaller cars. I think driver training needs to be a con-stant thing for all drivers, not just the elderly. Train them each time they renew their licenses.	Member asked about how the sur-vey will be used. She liked the idea.
17345	72	M	I can't think of any-thing specific that needs improvement except cover them with plastic to pre-vent stone chips and make them adaptive. I would like them to stay on all the time for safety especially in	I find the lights es-pecially beneficial when driving on twisty turning roads I encounter in north-ern California that are relatively unlit. The HID lights with their longer range are especially use-ful. I haven't had	I haven't changed my driving habits that I'm aware of. I got used to the HID lights in no time.	I would like stronger roof structures for roll over protec-tion. Stability control should be mandatory, Lane change warning systems research should be accelerated as well as brake systems with shorter braking distances. Cars are becoming too auto-mated (self parking Lexus) The result will be less in-	Member asked about how the sur-vey will be used and he recom-mended we get a copy to Bob Lutz of GM.

ID #	Age	Gender	Q20 – Improve-ments	Technology - Help-ful/Hurtful?	Change driving hab-its/Comments	Q24 - Mfg's not doing enough	Other ques-tions or con-cerns?
			heavy traffic. Mem-ber had HID lights only.	any problems with the lights.		volvement by the driver. The best safety device should be the driver. I would also like a device that shows you when a vehicle is beside your vehi- cle.	
20708	38	M	I would like to have driver-adjustable low beam lights like they have in Europe. European cars are available with a switch that adjusts from 1 to 5 with 1 being the lowest setting for city use and 5 being the highest for highway use. That would help greatly with the problem of brighter lights for low beams. Member has HID only	I find their greatest benefit is in country driving or in the de- sert where there isn't much light when driving. I haven't had any problems with the HID lights.	I haven't changed my driving habits and I got used to the HID lights right away.	That's a tough question, HID lights are great for me but I understand seniors have big problems coping with the blu- ish light they generate. More cars are being produced with electronic nannies like acci- dent avoidance and lane change warning systems, etc. that should help, unfor- tunately they are on high-cost cars now.	Member asked about how the sur- vey will be used and I explained.
15406	69	M	The range seems a little limited like you could overdrive your headlights if you are not careful, they need to be adjusted up a little bit. We purchased the car used so it could just need adjusting. Otherwise, the lights are great. Member	The lights are great at night on dark country roads which I drive a lot. I can really see things because they are much brighter.	I haven't changed my driving habits with the HID lights. It didn't take any time to get used to the lights. They are great except at speed which I mentioned ear- lier.	I think the manufacturers are doing enough with all the new safety technology. The new technology is a real feather in their cap.	Member asked about how the sur- vey will be used and I explained.

ID #	Age	Gender	Q20 – Improve-ments	Technology - Help-ful/Hurtful?	Change driving hab-its/Comments	Q24 - Mfg's not doing enough	Other ques-tions or con-cerns?
			has HID lights only.				
17080	35	M	I feel the low beam HID lights are pretty good as they are, but the high beams which are conventional halogen could be brighter. Member has HID only.	I find HID lights very helpful on rural roads. They allow you to see much further on hilly roads. They also light up the reflective signs much better. I have not experi-enced any problems using the HID lights.	I haven't really changed my driving habits al-though I feel much more confident driving with the HID lights. I feel safer at highway speed; you do not seem to be out-driving your lights like you do with conventional halogen lights. I picked up from the start, It did not take any time to get used to the lights, in fact I spe-cifically looked for HID lights when I bought my car.	The new car designs, yes they are doing enough with the comfort features and the ability to see. More needs to be done; the technology available on high-end cars needs to filter down to popu-lar priced cars.	Member asked about how the sur-vey will be used and I explained.
20918	68	M	I would like to see unbreakable head-light lens because of expense of re-placement. The lights themselves work fine. The member has HID lights only.	The lights work es-pecially well in light-ing up dark streets, you can see very well, both in front of and to the sides of the road. I did have problems with peo-ple flashing their lights at me. I went to the dealer and had him lower the lights which helped, although I can't see	I drive the same as be-fore I got HID lights. However, I see much farther now and feel safer. I got used to the lights right away, no problems.	I think the manufacturers are doing enough; Lexus has adaptive headlights now. I would like to see a convex portion on the bottom of the outside rear view mirrors to see vehicles right beside your car like the big trucks have.	Member asked about how the sur-vey will be used and I explained.

ID #	Age	Gender	Q20 – Improve-ments	Technology - Help-ful/Hurtful?	Change driving hab-its/Comments	Q24 - Mfg's not doing enough	Other ques-tions or con-cerns?
				as far now.			
19420	33	M	I think the HID head lights are pretty good as they are except when going up or down a hill when their sharp cutoff on top limits how far you can see. Member has HID only.	The HID headlights help greatly in dark areas where they light up everything around them, "day-light at night." The only problems I experienced are on hills as I mentioned.	I haven't changed my driving habits that I can tell. I can see more and feel safer because I can plan ahead.	Yes, I think they are doing OK.	None.
12858	73	M	The low beam appears flat on top which limits the range when approaching a hill. I need to use the high beams on unlighted roads when doing that. Otherwise the HID lights offer excellent light to the sides to see pedestrians and animals.	The HID lights offer excellent general coverage on unlit roads, except when approaching a hill as I mentioned. They are excellent on side streets. I haven't had any problems otherwise.	My driving habits haven't changed because of having HID lights. My previous vehicle had HID lights so I was already used to them.	The luxury brands of cars are getting more electronic technology each day and certain manufactures' control systems like the BMW "I Drive" and the Mercedes Benz touch screen system are becoming overly complex to use. They need more intuitive control systems for seniors.	Member asked about how the survey will be used and I explained.
20265	80	F	I find the light beam does not project far enough in front. I would like brighter lights that offer more coverage. I do experience problems with the glare of	Benefits - I find the lights beneficial in general driving at night, especially in dimly lighted residential areas. However, the glare from other vehicles gets	I haven't changed my driving habits because of the HID lights. It didn't take any time at all getting used to the headlights, they just need greater range.	No! I think the manufacturers are too busy trying to target younger drivers. They don't have health problems to deal with. Glare is a real problem with middle age and older drivers. You can't see out of the back of the cars and they	Member asked about how the survey will be used and I explained.

ID #	Age	Gender	Q20 – Improve-ments	Technology - Help-ful/Hurtful?	Change driving hab-its/Comments	Q24 - Mfg's not doing enough	Other ques-tions or con-cerns?
			other HID equipped vehicles. Member has HID only	me the most. I feel the sharply slanted windshields contribute to the glare problem. I have problems with my vehicle when I use valet parking, the attendants turn the "auto" function off when parking my vehicle and I don't always catch that and have driven at night without lights.		have way too many blind spots. The slanted windshields contribute to glare. The driver seats need to be higher and more upright.	
18393	34	F	I think the head lights are great as they are but would be even better if they were adaptive. The member has HID only	The headlights are great because they allow you to see from sidewalk to sidewalk in turns. We go to Oregon often and they are great on the forest roads where it's very dark. The only problem I have is with other drivers flashing their lights at me because they are very bright. I also have problems with other drivers' HID lights in my side rearview mirrors blinding me.	I haven't changed my driving habits because of the HID headlights. They didn't take any time to get used to.	I think the manufacturers are accommodating older drivers. The vehicles have a lot better interior features and content for the money than they used to. I would like to see more AC vents in the cars.	none

ID #	Age	Gender	Q20 – Improve-ments	Technology - Help-ful/Hurtful?	Change driving hab-its/Comments	Q24 - Mfg's not doing enough	Other ques-tions or con-cerns?
18736	68	M	I can see very well with them. My wife doesn't like them because she feels they bother other people. Perhaps people are getting used to them since other drivers seldom flash me anymore. The lights are definitely better than my conventional lights. Member has HID only.	I find the HID lights especially useful in areas without over-head lighting, like country roads and rural areas. They are almost as bright as my high beams. I haven't had any problems caused by the lights. I remember people complaining about day-time running lights when they first came out.	I don't think I have changed my driving habits, I don't drive any faster as a result of the lights, perhaps I was overdriving my conventional lights. It didn't take any time to get used to the lights.	I'm not sure what the manu-facturers would do for older drivers, I think they are doing OK	I think it's good to do the survey.
13633	71	M	I would like to see an auto shutoff fea-ture on my head-lights and I would like my lights to be adaptive like the later models. My high beam indicator is hard to see, that needs improvement, and otherwise they work fine. Member has HID only.	I find the lights really help when there are no other lights around like when I go to the Lawrence Welk retirement community and country areas and in curves especially. I haven't had any problems with the lights.	I haven't changed my driving habits because of the HID lights. It didn't take any time at all getting used to the headlights.	I haven't thought much about that, I have problems with my knees and my car doors close on my legs too easily since my driveway is on a slope. They need a better method of holding the doors open without being too hard to close. I would like greater seat travel when parked to allow me to get out of my car easier.	The member asked about how the sur-vey will be used and I explained.
12126	40	F	I feel the HID lights are too bright for oncoming cars; about one in ten cars flash me when I'm on two lane roads. Also I don't	I find the lights really help when I'm in rural areas or on two lane roads; I hardly ever have to use my high beams. I have-n't had any problems	I don't think I have changed my driving habits, I just feel more confident driving with them. It took me about six months to become used to the way they	I don't think the car manufac-turers are [doing enough], I can't think of any special things they are doing for older people like large lettering or special options just for seniors.	The member asked where the informa-tion is going. I explained the program.

ID #	Age	Gender	Q20 – Improve-ments	Technology - Help-ful/Hurtful?	Change driving hab-its/Comments	Q24 - Mfg's not doing enough	Other ques-tions or con-cerns?
			like the sharp cut off of the light beam, I can't see what's around some turns until my car completes the turn. It doesn't spread out like my old lights would. Member has HID lights only.	with my HID lights, just other drivers like I mentioned earlier.	are.		
12524	48	M	The HID lights have a sharp cutoff on the top, so while you can see street signs off in the distance, by the time you are close enough to read them the HID lights no longer illuminate them. Also you have trouble seeing up hills for the same reason. They need improvement in that.	The lights work especially well on country roads. We go to Arizona often and you don't really need high beams on the highway. The lights also work well in the fog. They haven't caused any problems.	I haven't changed my driving habits because of the HID lights. It took a couple of weeks to get used to them.	I think the manufacturers are doing OK for seniors.	I think it's interesting the Auto Club is doing this.
16899	60	M	I would like to see HID high beam lights also. Although we can't predict the future I feel HID lights are as good as it gets. Member has HID lights only.	I find the lights are great, they have a well defined light pattern that doesn't shine into the cars in front of you and they do a great job of illuminating the road. I haven't had any problems with them.	I haven't changed my driving habits because of the HID lights, I just feel more comfortable driving at night with them, I'm not overdriving my lights, you can definitely see better. It didn't take any time, they are just there!	Let's just say I think the manufacturers are doing an adequate job and leave it at that.	None, but please respect my privacy and don't sell my phone number.

ID #	Age	Gender	Q20 – Improve-ments	Technology - Help-ful/Hurtful?	Change driving hab-its/Comments	Q24 - Mfg's not doing enough	Other ques-tions or con-cerns?
20304	73	M	I would like to see the cost of replace-ment come down. I understand that they are high-theft items and expensive to replace. Member has HID only.	I don't see any bet-ter with the HID lights than with my older halogen lights. I can't drive any faster than before. The lights are defi-nitely brighter but from a practical stand point I don't see any improve-ment. I haven't had any problems caused by the lights.	I haven't changed my driving habits at all after getting the new lights.	That's a deep question! The cars today are so much eas-ier to drive than before. The brakes are great, the lights much brighter etc. I think they are doing a great job.	Member asked about how the sur-vey will be used and I explained.
18336	71	M	I would like an auto-matic on /off head light feature, I un-derstand later ver-sions of my car have that. I'm pleased with the HID lights perform-ance. They have an ideal compromise by cutting off the top of the light beam and still lighting the road. Member has HID only.	I find the HID useful any time its dark; the low beams are so good I rarely use the high beams any-more. I haven't had any problems with the HID lights; hardly anyone flashes me.	I don't think I have changed my driving habits. It didn't take any time to get used to the lights.	I don't know. They are not thinking about economy enough with seniors living on fixed incomes. I see more seniors driving poorly or hav-ing trouble driving. One thing manufacturers could do that would help is have a uniform height for headlights and bumpers. That way the bumpers would meet in an accident and you would not be blinded by all the SUVs and trucks.	Member asked about how the sur-vey will be used and I explained.
13015	58	F	I can't drive safely at night with my lights because I can't see far enough down the street with them. I have to use the high beams in	I don't find them beneficial at all, I can't see far enough down the street to drive safely at night. I don't like meeting them head-on at	I haven't changed my driving habits because of them; I'm still not used to them!	No, I would like to see a good sedan with more leg room. I want a comfortable sedan but not the boat my grandfather used to drive.	No, I'm glad to see the survey so I can vent about my lights.

ID #	Age	Gender	Q20 – Improve-ments	Technology - Help-ful/Hurtful?	Change driving hab-its/Comments	Q24 - Mfg's not doing enough	Other ques-tions or con-cerns?
			my neighborhood because it's not well lit. Member has HID lights only.	night in other cars.			
16350	37	M	My Acura TL's HID lights need greater range; they don't seem to shine very far. I felt could see much further with the non-HID lights in my Volkswagen Touareg. Member has HID only.	They are very useful in normal city driving with a lot of other ambient light at night. On a dark road I felt I could see farther in my Touareg. I haven't had any problems with people flashing me.	I haven't changed my driving habits and it didn't take any time to get used to them.	I'm not knowledgeable enough about the technology. I think it's keeping up with the older drivers. However you are talking to a law officer and I've seen a lot of bad drivers on the roads.	None, I hope it does some good.
15862	57	F	I find the lights produce a blinding white light. My car sits low to the ground and I still have other drivers flash me on a regular basis thinking I have the high beams on when I don't. This needs improvement. From a driver's standpoint I love the lights. Member has HID only.	I find the lights especially beneficial when driving in the orange groves and unincorporated areas without streets lights in Riverside. I can see what's on each side of the road because of the wide arc of bright light they produce. I haven't had any problems with the lights except other drivers flashing me.	I haven't changed my driving habits because of the HID lights and it did not take anytime to get used to them.	For the most part I think the manufacturers are doing their part to accommodate older drivers or at least as good as they can. I had a chance to ride in my neighbors' restored 1966 Mustang and realized how unsafe the older cars were. I think all vehicles should be equipped with backup sensors like my mom's car has, they are great!	No questions, I'm glad to see the Auto Club doing things like this.
14047	53	F	The plastic lens has turned funny looking, it's not clear anymore, its cloudy	I don't pay much attention to my headlights, I drive from Santa Barbara	I haven't changed my driving habits and it did not take any time to get used to the new lights.	I think the manufacturers have done their job of making safe cars, how safe can they get? The DMV hasn't done	none

ID #	Age	Gender	Q20 – Improve-ments	Technology - Help-ful/Hurtful?	Change driving hab-its/Comments	Q24 - Mfg's not doing enough	Other ques-tions or con-cerns?
			looking. Other than that I haven't had any problems with the lights. Member has HID only	to Salt Lake City and kind of get used to what I have. They are better than what I had before. I do notice a sharp cut off on the top of the low beam light.		their job of taking the driving licenses away from the older drivers that should not be driving! I think beyond a certain age they should be tested every year, it's scary! She gave her parents as examples of elderly drivers who should not be driving.	
19525	41	M	I would like to see HID high-beam lights also since the HID low beams work so well. Member has HID headlights only.	I find them especially useful in dark areas without a lot of overhead street lights. I haven't had any problems with flashing me or things like that. I have heard of people stealing the HID lights to put in Honda Civics and the like.	I haven't really changed my driving habits, if I did it's probably that I drive a little faster at night since I can see better. It didn't take any time to get used to the lights.	It's hard to say if they are doing enough, I'm not that old. If I had to say something it's that the interiors of cars are becoming more complex and that might be a distraction to seniors. An example would be the automated climate control systems that are complex and require you to take your eyes off the road to adjust.	I explained the use of the survey
14628	63	F	The HID lights work fine as they are. However, when I turn on the headlights my dash lights go out. I will have to take it to the dealer and have him look at it. The car was a gift. Member has HID lights only.	I primary drive in the city and the headlights work fine. I haven't had any problems with people flashing me or things like that.	I haven't changed my driving habits because of the HID headlights and it didn't take any time getting used to them.	I really can't answer that, I don't know about auto manufacturers as a whole. However, I think Nissan has [done enough] with my Maxima. Member was rushed for time.	No questions, I think it's good the Auto Club is doing this.

ID #	Age	Gender	Q20 – Improve-ments	Technology - Help-ful/Hurtful?	Change driving hab-its/Comments	Q24 - Mfg's not doing enough	Other ques-tions or con-cerns?
19979	39	M	I think the HID headlights work fine I would like to have HID high-beam headlights as well. They work fine in all conditions. Member's vehicle in survey had HID only. His brand new vehicle also has adaptive headlights. The same comments apply [to the new vehicle] except it is much easier seeing when turning corners etc.	I haven't had any problems because of the lights. The HID headlights are great, they are easy to maintain and last a very long time. The HID lights are especially helpful when you have a little night blindness like I have, you can see much better.	I have changed my driving habits; I drive a little faster at night and especially in bad weather because I can see about 40% better than before. It didn't take any time, you can see much better instantly. When I drive rentals with out HID lights I have to adjust back!	I don't think they are doing all they can, HID lights were not even offered on the car my parents bought. I think safety items like HID headlights and multiple side impact air bags etc. should be standard on all cars not just expensive ones. Also I think Blue Tooth technology should be offered on every vehicle.	Member asked about how the survey is going to be used and I explained its purpose.
13157	47	M	I think my headlights are fine it's the other vehicles HID lights that cause problems for me. Bright lights are a migraine headache trigger for me. I can hardly drive at night because of this, especially with all the jacked up trucks and misaimed headlights. Member has HID only.	I find the lights especially useful in areas without overhead street lights, they work great. Problems, I was "Flashed" a few times when I first got my car but it's not a problem now. Also have problems on angled intersections where you tend to blind the other driver when your car is pointed slightly up in relation to another vehicle.	I haven't changed my driving habits. I guess it took a little while to get used to them.	I don't think the manufacturers are doing enough. My mother just brought a new car and she's having problems figuring out how all the controls work. They just turn older drivers loose with a new car. I think they should offer a DVD or some training on how to use all the new stuff.	No questions, member was rushed for time.

ID #	Age	Gender	Q20 – Improve-ments	Technology - Help-ful/Hurtful?	Change driving hab-its/Comments	Q24 - Mfg's not doing enough	Other ques-tions or con-cerns?
16039	50	M	The HID lights only shine down the road. They do not easily illuminate the street signs without using the high beams. Member has HID only.	The HID lights are visibly brighter and more useful because of that. I haven't had any problems with other drivers flashing me.	I haven't changed my driving habits because of the HID light. It didn't take any time at all to get used to them.	I don't know the answer. I think they are accommodat-ing older drivers. Think of a Cadillac with its accessories. Everything I can think, of Cadillac has as far as practi-cal accessories. He asked what others had mentioned.	He asked how the study would be used. I ex-plained our intent.

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