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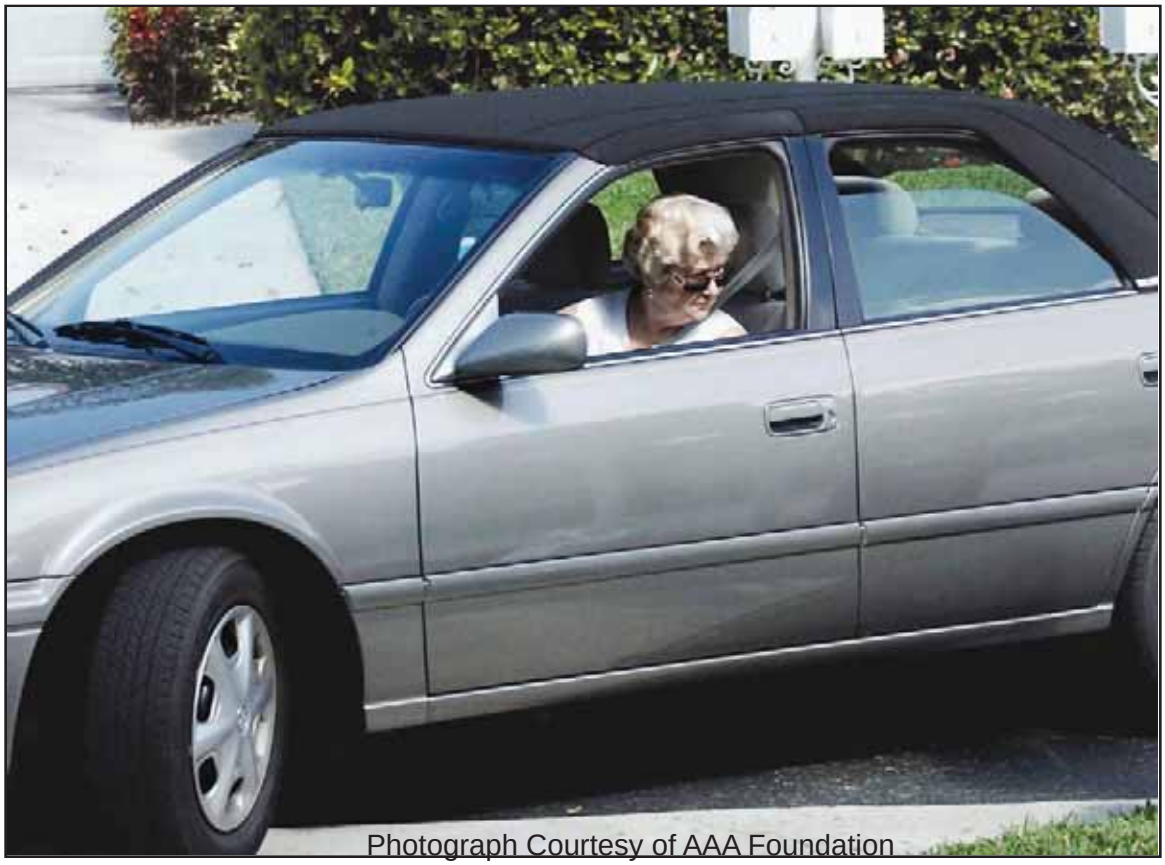
Use of Advanced In-Vehicle Technology by Young and Older Early Adopters

Results on Sensor-Based Backing Systems and Rear-view Video Cameras



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James W. Jenness, Neil D. Lerner, Steve Mazor, J. Scott Osberg, Brain C. Tefft

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16. Abstract This document describes the results of survey research undertaken by the Automobile Club of Southern California. Questionnaires (10,000) were mailed to insurance customers who own vehicles that had a sensor-based backing aid (parking aid) system or rear-view video camera as standard or optional original equipment. Half of the questionnaires were mailed to vehicle owners who were younger than 65 years, and half of the questionnaires were mailed to owners who were 65 or older. The response rate was approximately 30 percent. Follow-up telephone interviews were conducted with 42 backing aid owners and 46 rear-view camera owners. 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).			
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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 (ACSC). The two surveys described here were designed to assess drivers' experiences with backing- and parking-assistance technologies, including sensor-based backing aid systems and rear-view video camera systems. These two technologies are still relatively new to the U.S. passenger vehicle fleet and the purpose of the study was to learn about early adopters' experience using these systems. 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. The overarching goal of the study was to learn more about the extent to which backing aid systems and rear-view cameras 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 such as backing aid systems and rear-view camera systems are misunderstood and misused in dangerous ways. A major focus of the data analysis was to compare the responses of older drivers (65 years or older) to those of younger drivers (younger than 65 years old).

Technology-specific questionnaires were mailed to 5,000 potential backing aid owners and 5,000 potential rear-view camera owners. Both samples were selected by ACSC from its database of insurance customers. Only owners of particular vehicle makes and models known to have the backing aid or camera technology as a standard feature or available option were invited to participate. Half of the questionnaires were mailed to owners who were younger than 65 years old, and the other half were mailed to vehicle owners who were age 65 or older. Vehicle owners were asked to mail back the questionnaire to ACSC in a self-addressed postage-paid envelope even if they did not have the technology. Although no money or other incentives were offered to potential respondents, approximately 30 percent of the questionnaires were returned, including questionnaires from 1,087 backing aid owners and 1,069 rear-view camera owners. In addition to the written questionnaires, ACSC staff conducted brief telephone interviews with 42 backing aid respondents and 46 rear-view camera respondents to gather additional information about their experiences with the technologies and their suggestions for system improvements.

The sample of backing aid owners differed in several respects from the sample rear-view camera owners. Respondents with backing aid systems tended to be older and had more experience (miles) driving their current vehicle than did rear-view camera owners. More of the respondents with rear-view cameras were women (47%) as compared to those with backing aid systems (38%).

Desire to have backing assistance technologies

An overwhelming majority of those who currently have either a backing aid system (98%) or a rear-view camera (93%) said that if they purchased their same vehicles again, they would want to get the technology again. Among those who do not have the technology, the most common reasons cited for not purchasing it were related to availability on the specific vehicle that they purchased or lack of knowledge about the system. Cost was cited as a reason by

9 percent of those who did not purchase a backing aid system and by 21 percent of those who did not purchase a rear-view camera.

Learning to use the technology

Similar patterns of results were obtained on the backing aid survey and the rear-view camera survey for the methods that owners used to learn how to operate their systems. The most frequently reported methods were "on-road experience and practice (trial and error)" and "instructions from the dealership." Among backing aid owners, the proportions of respondents who cited these learning methods varied significantly by vehicle manufacturer.

Behavioral adaptation

The percentage of rear-view camera owners who said that they use their system more now than when they first obtained their vehicle was not significantly related to their level of experience with the vehicle. However, backing aid owners seem to rely more heavily on their systems as their experience with their vehicles increases. Owners of either type of system generally are more confident about their backing abilities using the system, and it may be concluded from the results that many of them tend to back up faster and to park in tighter parking spaces than they would if they didn't have the systems. With the systems in their vehicles some owners rely less on checking mirrors and making direct glances over their shoulders.

- If their systems stopped functioning, approximately a third of backing aid and camera owners said that their driving behavior would not change. However, approximately 61 percent of both backing aid owners and rear-view camera owners said that they would rely more on their mirrors and/or glances over their shoulders. A higher percentage of backing aid owners (40%) than rear-view camera owners (27%) said that they would back up much more slowly. The proportion of backing aid owners who said that they would avoid parking in tight spaces and the proportion who would back up much more slowly tended to increase with experience.
- Approximately 17 percent of rear-view camera owners and 12 percent of backing aid owners admitted backing without checking their mirrors or turning to look out the rear window within the last two weeks. Younger rear-view camera owners were more likely have done this than were camera owners age 65 or older.
- Approximately 67 percent of rear-view camera owners said that they normally share their attention equally between the rear-view camera screen, mirrors, and direct glances out the rear window, and 22 percent said that they usually just take a quick glance at the camera screen to determine if they can back up. Seven percent pay more attention to the camera screen than to mirrors or direct glances out the windows. Younger respondents were more than twice as likely as older respondents to do this.
- Approximately 70 percent of respondents agreed that they are more confident in their ability to detect pedestrians when they use the backing aid systems.
- Several items that asked owners to agree versus disagree with specific statements about their use of the technology indicate increased reliance with higher levels of experience.

- Nearly 18 percent of backing aid system owners reported that since getting their vehicles they had experienced a backing collision or "close call" while they were driving another vehicle without a backing aid system because they expected to receive a warning.

Perceived effectiveness

Backing aid owners were generally satisfied with the performance of their backing aid systems under several different weather conditions, although for some conditions such as snow a large percentage of respondents didn't know how well their systems would work. A topic of greater concern than performance in weather is that a large percentage of respondents thought that their backing aid systems would help them to avoid a collision under several scenarios where the technology would likely not be effective. In fact, a majority of respondents thought that their systems would be effective when:

- Backing quickly (10 mph)
- Backing out of a driveway into the street and into the path of an oncoming car
- Backing out of a garage when there is a child immediately under the rear bumper
- Backing out of a parking space and there is a pedestrian standing 10 feet behind the rear bumper
- Backing up to a narrow sign post

Overall, respondents seemed to be very pleased with (or confident about) the performance of their backing aid systems. They agreed that their backing aid systems:

- Give them a good idea of their distance from an obstacle (89%)
- Give them enough warning time to avoid hitting an obstacle (92%)

Only 6 percent thought that the backing aid systems give them too many false warnings when they are not in danger of hitting anything, and only 3.8 percent agreed that the backing aid fails to warn them about an obstacle when it should have.

Among owners of rear-view cameras, most thought that their cameras worked fairly well or perfectly in various weather conditions, or didn't know. The conditions that gave the most people trouble were:

- Bright sun (10%)
- Darkness (9%)
- Fog (6%)
- Rain (5%)

Several dozen respondents (n = 45) mentioned difficulties with the camera systems when backing from either light to dark areas or from dark to light areas.

User interface and usability

There were only a few questions on the survey which addressed the user interface of backing aids. Most backing aid owners in the survey rely on auditory indications from their systems,

although many may not have (or be aware of) any visual indicators as part of the user interface to their system. Younger drivers were more likely than older drivers to strongly agree that the sounds made by the system were easy to hear.

For rear-view camera systems:

- Most respondents (96%) found their camera to be easy or very easy to use when backing out of a driveway.
- Approximately 36 percent of respondents agreed or strongly agreed with the statement that "the rear-view camera does not show the entire area behind my vehicle that I need to see when backing, in other words there is a blind spot."
- Five percent of respondents agreed that dirt on the rear-view camera caused a problem for seeing obstacles
- Most respondents did not agree with the statement that "it's hard to distinguish something or someone who may be in a shadow area behind my vehicle (image contrast is poor in camera)." However, older camera owners were less likely than younger camera owners to disagree or strongly disagree, possibly indicating that older owners may have more trouble seeing objects in the video images.
- Infiniti owners were singled out for analysis regarding the video overlay system of lines and markings on their systems which help the driver to judge distance and predict backing direction. Nearly every Infiniti owner who has this system found it useful. Responses to several other items on the questionnaire differed by vehicle manufacturer, and Infiniti owners generally rated their systems more highly than did Acura or Lexus owners.
- Infiniti owners and owners younger than 65 years old tended to agree more strongly with the statement that "it's easy to tell how close I am to an obstacle by looking at the rear-view camera."
- Sun glare on the video display was a problem for 27 percent of respondents. Among the three vehicle manufacturers compared, Acura owners were most likely to agree that sun glare is a problem.
- The location of the screen (video monitor) seems to be satisfactory for most camera owners. Only 2 percent disagreed or strongly disagreed that it is in a location where it is easy to see when backing. Higher proportions of younger respondents and Infiniti owners tended to strongly agree that the screen location was easy to see.

Safety

- The majority of both backing aid owners and rear-view camera owners thought that having their systems made them safer drivers. Less than one percent thought that it made them less safe.
- Seven percent of rear-view camera owners and three percent of backing aid owners said that their systems create some safety concerns for them. The most commonly mentioned concern was becoming too dependent on their systems.

- Only 21 percent of backing aid owners and 39 percent of rear-view camera owners reported that they were aware of "any warnings or limitations" about their systems. The percentage of respondents who said that they were aware of warnings or limitations varied significantly by vehicle manufacturer.
- Since obtaining their vehicles, 14 percent of both rear-view camera owners and backing aid owners reported having backed into something or had a "close call." The last time this happened, only a third of the respondents said that they got out of their vehicles to check for obstacles. Younger respondents were more likely to have gotten out of their vehicles to check for obstacles than were older respondents.

Need for system improvements

The two most frequently cited areas suggested for improvement for the rear-view camera were to increase the coverage of the camera view and to improve the quality of the picture shown on the rear-view monitor. For backing aid systems the most common suggestions involved improving the range of sensors to the sides of the vehicle and adding more audio features.

Comparisons by age group

Responses from system owners who were 65 years old or older were compared to responses from system owners who were younger than 65. In addition to differences mentioned in the sections above, some of the other significant age-related differences are listed here.

For the backing aid survey, older respondents:

- Were more likely than younger respondents to say that they would want to get the system again.
- Were more likely to have learned how to operate their systems from the owner's manual. (A higher percentage of younger respondents learned to use their systems from on-road experience and practice.)
- Were less likely to be aware of warnings and limitations about their system.
- Were more likely to say that they would "rely more on mirrors and/or glances over my shoulder" if their backing aid systems broke down. (A higher percentage of younger respondents would "not try to fit into tight parking spaces.")
- Had a different distribution of responses for certain items that asked owners to rate how well their backing aid systems would assist them to avoid colliding under different circumstances. The specific circumstances where ratings from older and younger system owners differed were: Q13A – slowly backing out of a driveway into the street and into the path of an approaching car; Q13C – backing out of a garage and there is a child immediately under the rear bumper; Q13F – backing into a parallel parking space where you have to back very close to the car behind you. A higher percentage of older owners tended to say that they didn't know, and a higher percentage of older owners said that their systems would work "not at all" for these scenarios.
- Were less likely to report that they unintentionally backed into something or had a close call while driving their vehicles as compared to younger system owners. (Older

respondents also were less likely than younger respondents to report that they had a backing collision or close call while driving another vehicle without a backing aid system because they expected a warning.)

- Were more likely to disagree (and strongly disagree) that they tend to use their mirrors less often than they would if they didn't have the backing aid system.
- Were more likely to disagree that they are more willing to park in small or difficult parking spaces when they use the backing aid.
- Agreed less strongly that the system gives alerts with enough time to avoid hitting an obstacle.
- Tended to disagree more strongly than younger drivers that the backing aid gives too many false warnings.
- Were less likely than younger drivers to say that they "rely on the backing aid system more now than I did in the beginning."
- Were less likely to say that the backing aid system should be improved.

On the rear-view camera survey, older respondents:

- Were more likely to have learned how to operate their systems from the owner's manual. (A higher percentage of younger respondents learned to use their systems from on-road experience and practice.)
- Were less likely to say that the system was very easy to learn to use, and were more likely to say that there were things that were especially difficult to learn (e.g., judging distance).
- Were less likely than younger respondents to say that they used the rear-view cameras more now than when they first got the vehicles, and they were more likely than younger respondents to say that their usage had stayed the same.
- Were less likely to strongly agree that the rear-view camera screen is in a location where it is easy to see when backing.
- Were less likely to agree or strongly agree that they are more willing to park in small or difficult parking spaces when using the rear-view camera.
- Were more likely to be bothered by sun glare on the camera's video display, making it hard for them to see objects or people.
- Were less likely to strongly disagree or disagree that the image contrast level is poor in the camera, making it difficult to see something or someone who may be in a shadow area behind the vehicle.
- Were less likely to say that having the rear-view cameras makes them safer drivers.

Conclusions

The survey methodology used in this study was an efficient way to assess a large number of drivers' perceptions about backing aids and rear-view camera 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. Owners of backing aid systems and rear-view cameras generally said that their systems work well and make them safer, although many drivers were not aware of system limitations and tended to overestimate the effectiveness of their systems. Many differences were found between younger and older respondents, and in some cases responses depended on the respondent's level of experience with the vehicle. Certain limitations and implications of the study are discussed at the end of the report.

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

This report describes survey research conducted with owners of sensor-based backing aid systems and rear-view video camera systems. It is the first in 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 partnered with the Automobile Club of Southern California (ACSC) to administer mail-out surveys to individuals 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 age 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 (age 65 or older) to those of younger drivers (younger than 65).

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 adaptive headlamps
- Navigation systems
- Adaptive cruise control

A total of 40,000 questionnaires were mailed to ACSC insured members who were invited to participate based on the known manufacturers, models, and model years 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
Adaptive Cruise Control	10,000
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 backing aid systems and rear-view camera systems.

BACKING AID SYSTEMS AND REAR-VIEW CAMERAS

NHTSA (2006a) estimates that there are at least 183 fatalities and between 6,700 and 7,419 injuries that result from backover crashes each year in the United States. The actual numbers are difficult to determine because many of these crashes occur on private property and are not recorded in either State of Federal crash databases. Nevertheless, it is clear from these estimates that finding ways to reduce backover crashes may have the potential to significantly improve public safety. Many backover crashes are due to the fact that despite checking mirrors and making direct glances out the rear window of the vehicle the driver may not be able to see obstacles in certain areas (blind spots). The extent of blind spots varies with vehicle type and driver eye height.

In recent years, many large vehicles such as SUVs have been added to the U.S. passenger vehicle fleet, and the owners of these vehicles as well as many modern smaller vehicles may or may not appreciate the full extent of blind spots to the rear of their vehicles. Relatively new technologies on some vehicles help drivers partially compensate for rear blind spots by providing ultrasonic-based (sometimes radar-based) detection of obstacles or by providing indirect rear visibility through a video camera system. However, backing aids do not cover the entire blind spot behind the vehicle where a driver cannot see with mirrors and direct glances. The extent of rear blind spots, and coverage areas for rear-view camera and backing aid systems for some vehicles have been documented recently by NHTSA (2006b).

The backing problem may be especially difficult for older drivers who tend to develop reduced flexibility and mobility of the head and neck. These drivers sometimes may have difficulty safely backing because they may fail to adequately check mirrors and make glances over their shoulders towards the sides and rear of the vehicle. The safety impact of sensor-based backing aids and rear-view camera technologies is not known. For older drivers in particular, these technologies may improve backing safety. At the same time, it is possible that drivers may rely too much on these systems or may misunderstand the limitations of the systems. Project partners have an interest in better understanding drivers' experiences with these systems as they relate to human factors concerns such as usability of the systems, drivers' behavioral adaptations to their systems, and perceived effectiveness of the systems.

For the purposes of this study, the generic terms, "backing aid system" and "backing aid" have been used to refer to the class of sensor-based parking assistance systems that are intended to assist drivers in performing low-speed backing and parking maneuvers by providing some form of signal (typically an auditory tone) to communicate the presence of and distance to obstacles. The vast majority of systems limit coverage to the rear of the vehicle, however, approximately 27 percent of all model lines are offered with both front and rear coverage zones. Typically, these systems use ultrasonic sensors to detect the proximity of obstacles to the vehicle's bumper. These systems are being sold under a variety of names, including Park Distance Control, Rear Parking Assist, Reverse Park Aid, Parktronic, and Reverse Sensing Warnings, among others. Although these systems are primarily marketed as a driver convenience feature rather than as a safety feature (collision warning system), some consumers may mistakenly believe that the system will help them to avoid collisions with all potential obstacles including small moving children and animals. The potential mismatch between backing aid systems' capabilities and owners' understanding of these capabilities is a

safety concern, particularly if drivers tend to place too much reliance on the systems or exceed their capabilities.

As of November 2005, there were 31 vehicle manufacturers (vehicle makes), and approximately 100 different 2005 (or 2006 if available) model lines offering backing aid systems and/or rear-view cameras in the U.S. market; 26 model lines offered a backing aid system and/or rear-view camera as standard equipment (Llaneras, Neurauter, Singer, and Jenness, 2005). For the purposes of this project, ACSC updated the inventory to include the 2006 model year. The numbers of manufacturers and model lines offering backing aids and rear-view cameras are shown in Table 1. An increasing number of manufacturers are incorporating the use of rear vision systems that provide drivers with an indirect view out the rear of the vehicle using a camera and in-vehicle monitor. Unlike a backing aid system, most rear-view camera systems are passive in the sense that they do not directly alert the driver to the presence of an in-path obstacle with a sound or a light. Only a limited number of manufacturers offer vehicles with both types of systems.

Table 1. Availability of vehicles equipped with sensor-based backing aid systems and rear-view cameras in the United States (2005-2006 model years)

	Vehicle manufacturers	Model lines offering feature (standard or optional)	Model lines offering feature as standard equipment
Backing aid only	21	82	22
Rear-view camera only	0	8	2
Backing aid and rear-view camera	10	10	2

Functional Characteristics of Backing Aid Systems

The sections that follow highlight interface and operating characteristics for a sample of backing aid systems and rear-view cameras; the sample is intended to provide a representative range of systems, especially systems that were owned most frequently by survey respondents. The device descriptions given below were taken from an inventory of in-vehicle devices that was conducted as part of the current project and previous projects (Llaneras and Singer, 2002; Llaneras, 2004; Llaneras, Neurauter, Singer, and Jenness, 2005). Functional characteristics of the sensor-based backing aid systems reviewed may be summarized as follows:

- The primary means of communicating distance information appears to be through audible signals to drivers. Of the systems reviewed, all provide audible signals to indicate distance although many also provide some form of visual display.
- The majority of audible signals take the form of tones or beeps which increase in frequency as the distance between the vehicle and the obstacle decreases; these become steady or continuous to indicate that the minimum distance has been achieved.

- No common threshold for this minimum distance (or final stage warning) appears to have emerged. Staged alerts were a common warning approach. For some systems, the "final stage" warning occurs when the distance to the object is 10 inches; others have set the final warning at 18 or 21 inches. Of the ten systems reviewed, six of them issue the final stage warning at or under 12 inches.
- For vehicles including both front and rear coverage, systems tended to provide visual displays to code direction and/or directionally code the auditory signals using the vehicle's speaker system.
- System operating ranges were somewhat variable, between 3 and 20 mph. Many systems (5 of 10) were intended to function at or below 6 mph – consistent with low-speed parking and backing situations.
- Most systems activate automatically and include a control or switch for manually turning off or overriding the system.
- Owner's manuals tended to caution drivers that systems were intended as aids when parking to avoid large obstacles and damage to the vehicle. Few, if any, effectively made the distinction between a park aid (backing aid) and a collision warning system. Most available systems are designed to detect the proximity of, and prevent backing into, stationary obstacles as opposed to pedestrians, children, and pets.

Cadillac Ultrasonic Rear Parking Assist

The Ultrasonic Rear Parking Assist system (reviewed as part of the 2004/2005 Cadillac XLR and 2004 DeVille model lines) automatically engages when the shift lever is set to reverse and the vehicle is traveling under 3 mph. No manual override is provided. Four ultrasonic sensors located on the rear bumper warn drivers of objects out to 5 feet (the system can detect objects 3 inches and wider and at least 10 inches tall). The visual display, consisting of three LEDs (Figure 1), is located inside the vehicle, below the rear windows and can be viewed through the rearview mirror or directly over the shoulder. A series of staged warnings are provided to the driver using audible tones and the visual display. When objects are detected at 5 feet, an initial alert is provided – a chime sounds and one amber light illuminates. At approximately 3 feet (40 inches), two amber lights on the display illuminate. At approximately 1.5 feet (20 inches) a continuous chime sounds and all three LEDs (two amber and one red) illuminate. The last stage is provided when the object is 1 foot away – the chime continues to sound and all three LEDs flash. The system does not operate at speeds above 3 mph; the display flashes red to denote an over-speed condition. The owner's manual cautions drivers that the system does not detect objects beyond 5 feet away, and to check carefully before backing up.

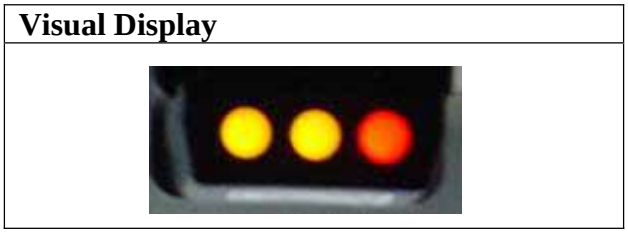


Figure 1: Cadillac Ultrasonic Rear Parking Assist visual display

Ford Reverse Sensing System

Ford's Reverse Sensing System (reviewed as part of the 2004 Freestar model line) provides rear coverage (out to a range of approximately 6 feet) while executing low-speed backing maneuvers using ultrasonic sensors located on the rear bumper of the vehicle. The system issues an audible tone when in reverse gear and an obstacle is detected. The rate of the tone increases as the distance between the vehicle and object decreases; the tone becomes steady when the obstacle is less than 10 inches from the rear bumper. A manual override control allows drivers to turn off the system (Figure 2); a visual indicator located on the control illuminates when the system is disabled. The system defaults to an on position every time the reverse gear is selected. The owner's manual states that the Reverse Sensing System is not effective at speeds greater than 4 mph, and that the system "may not detect certain angular or moving objects." It also warns drivers that the system is intended to help prevent damage to the vehicle, and that it is not intended to prevent contact with small or moving objects, particularly those close to the ground. Ford's system also warns of a moving object approaching at 3 mph or less, if the vehicle is in reverse gear but is not moving backwards.

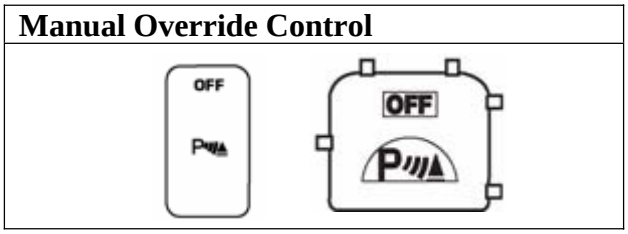


Figure 2: Ford's Reverse Sensing System override control

Lincoln Extended Rear Park Assist

Lincoln's Extended Rear Park Assist system (reviewed as part of the 2004 Navigator and Town Car model lines) is unique since it represents a hybrid using both radar and ultrasonic sensors to detect obstacles during backing maneuvers at speeds below 6 mph (the system uses Delphi's Forewarn® Back-up Aid). Use of radar affords the system a longer detection range, and makes it possible to provide a warning to the driver that is based on vehicle approach speed and not simply proximity to the obstacle. The system operates much as Ford's Reverse Sensing system, providing audible tones which increase in rate with decreasing distance to the obstacle, and it is engaged automatically when the vehicle is in reverse gear. However, the Lincoln system has a much greater detection range capable of detecting obstacles up to 20 feet behind the rear bumper. The system is unique in that it provides a warning to drivers when it detects high rates of closing distances requiring immediate braking by the driver. The warning consists of a "very high rate tone" which is distinct from the standard tone. The owner's manual indicates that if the warning tone is heard, "the driver is advised to slow down immediately until the tone either changes to a slower rate or stops." The system also automatically adjusts the radio volume when issuing alerts (this feature can be overridden by drivers), and provides the capability for drivers to disable the system using a control located on the message center. The system provides audible cues only, with no visual display.

Toyota Park Assist

The Toyota Park Assist system (reviewed as part of the 2004/2005 Sienna) uses sonar (ultrasonic) technology to provide front corner and rear sensor coverage out to approximately 6 feet (rear), and 2 feet (forward corners); limited rear corner coverage is also provided (Figure 3). Unlike other dual coverage systems, the Toyota Park Assist system does not provide front forward sensors (just front corners). Some models/configurations are also only equipped with rear sensor coverage (no front corner coverage). The system operates at or below 6 mph and works when the ignition is on and the vehicle is set to any position other than Park. A switch is used to turn the system on and off (the manual does not make it clear whether the system automatically activates or if the driver must first manually turn on the system). The distance to an object is provided through an indicator and auditory signal (buzzer) which is coded based on distance to the object. The owner's manual does not provide detail on the how the visual indicator functions. Coverage areas are presented in table form for the various zones (rear sensors, rear corner sensors, and front corner sensors). For the rear sensors, an intermittent buzzer means that the detected obstacle is approximately 3-6 feet away; a fast intermittent buzzer indicates that the object is approximately 2-3 feet away; and a continuous buzzer means that the object is 1.8 feet or away or closer.

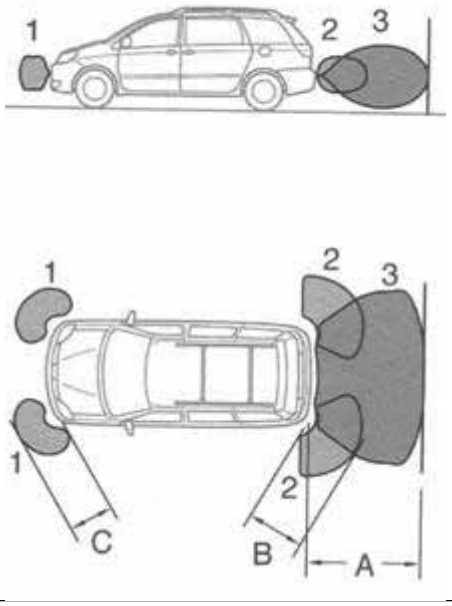
Controls	**Coverage Areas**
	

Figure 3: Toyota Park Assist interface elements

Functional Characteristics of Rear-View Camera Systems

Relatively few (10) manufacturers currently offer rear vision systems, providing drivers with an in-cab view of the area behind the vehicle when backing and parking. Rear-view camera systems are intended to aid in parking and avoiding obstacles, but unlike sensor-based

backing aid systems, do not provide an active warning to indicate the presence of rear obstacles. Rear-view cameras may allow drivers to detect unexpected and unseen obstacles such as children and pets while backing. However, they require direct glances to an in-vehicle display which is often located outside of a driver's typical line of site when backing; rear images are usually displayed on existing multi-functional displays (located on the center console) used to provide navigation and other vehicle system information.

Rear-view camera systems operate independently of sensor-based backing aid systems; although eight manufacturers offer vehicles with both types of systems. Rear-view camera systems tend to share several common attributes and characteristics:

- Images tend to be displayed using the same monitor as the navigation system.
- Systems tend to automatically engage and display images when the vehicle is shifted into reverse gear.
- Systems generally present a wide-angle, color view of the rear area.
- Systems are subject to issues with image clarity under several environmental lighting and weather conditions.
- Systems do not issue audible alerts or otherwise warn drivers to the presence of rear obstacles (drivers must detect in-path obstacles).

None of the reviewed factory installed camera systems use stand-alone monitors or integrate their displays into existing mirror systems, although there are some aftermarket products available which do embed the rear display into the rear-view mirror. All of the reviewed manufacturer's systems warn drivers to exercise caution while backing and to not exclusively rely or depend on the monitor when backing (some systems use an on-screen warning). All appear to operate while backing at any speed.

Acura Rear Camera System

The Acura MDX, an SUV, offers a rear camera system which automatically engages when the vehicle is placed into reverse (the camera is standard on the Touring package when also equipped with a navigation system). The image from the lift-gate-mounted camera is displayed on the navigation system display which is located on the center stack area. No information overlays or enhancements are include in the displayed image.

Infiniti Rear View Monitor

Infiniti offers an optional Rear View Monitor on four of their model lines; the system is standard on the Q45 and QX56. When the vehicle is shifted into reverse, a camera sends a wide-angle view of the area behind the vehicle to an in-vehicle monitor; the image is displayed automatically and uses the same display as the navigation system. The rear-view monitor remains activated as long as the gear shifter is in reverse and the vehicle ignition is on. The displayed image is enhanced with two types of supplemental elements or information overlays. The first is a set of fixed guidelines that serve as reference markers to indicate distances to objects from the bumper using color-coded segments; these guidelines scale distances to objects at 10 feet (green), 7 feet (green), 3 feet (yellow), and 1.5 feet (red). The second enhancement consists of a line overlay that projects the vehicle's predicted backing path (a predictive course line); this line is only displayed when the steering wheel is turned to the left or right. Drivers can adjust the screen brightness, tint, color, and contrast. Drivers are instructed to "turn and look before backing" both in the owner's manual and on the display screen itself. The owner's manual also cautions drivers about several display/system characteristics, including the following:

- Objects viewed in the monitor differ from actual size due to the wide angle lens.
- There may be a brief delay in displaying the image after shifting into reverse; objects may appear distorted until the rear-view monitor screen is completely displayed.
- Objects may not be displayed clearly under the following conditions: when strong light is directed at the camera; at night or in a dark area; and under high/low temperatures.
- Objects viewed in the monitor are farther than they appear when backing up a hill, and closer than they appear when backing down a hill.
- The system will not detect small objects below the bumper, and may not detect objects close to the bumper or on the ground.

Lexus Rear View Monitor System

Lexus offers a Rear View Monitor system on five 2005 vehicle models; the system comes standard on the LX470 and RX440. The monitor provides a wide-angle, color view behind the vehicle which is automatically displayed on the navigation system screen (typically located on the center console) when the shift lever is set to reverse gear and the ignition is on. No enhancements are overlaid onto the displayed image. As shown in the illustration below, the coverage area is limited and will not display objects that are close to the bumper or under the bumper. The screen automatically returns to the previous display when the vehicle is shifted out of reverse, or if a navigation system function is accessed. The owner's manual does not detail any information regarding screen adjustments (e.g., brightness, contrast, etc.), but the manual does outline several situations in which the displayed image may be difficult

to clearly see (e.g., nighttime and dark settings, high/low temperatures, rain, direct bright light onto camera, dirty camera lens, etc.). Lexus models with both park assist and the rear-view monitor system integrate the camera systems by displaying a warning icon on the rear vision monitor when the park aid sensors detect an obstacle (Figure 4).

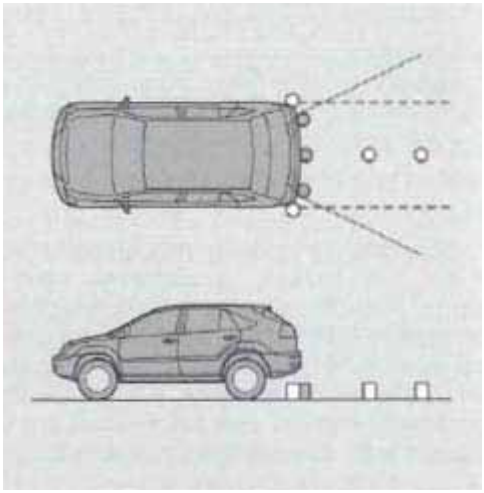
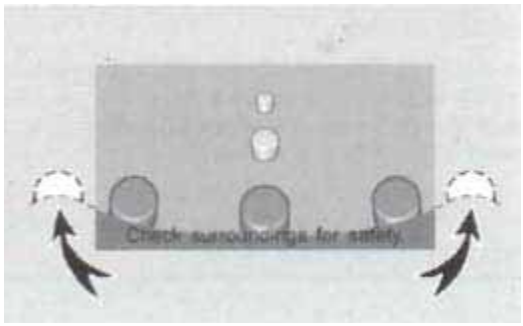
Lexus Owner's Manuals Diagrams	
	

Figure 4: Lexus Rear View Monitor

DEVELOPMENT OF SURVEY INSTRUMENTS

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.
- Acceptance of the technology – desire to obtain 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
- Need for improvements – owners' suggestions for needed improvements regarding the technology and regarding the design of vehicles for older persons

All of the questionnaire items are listed in Table 2 (for backing aid) and Table 3 (for rear-view camera). 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 2. Backing aid system questionnaire: Content areas and associated items

Background	1. Age 2. Gender 3. Do you have physical conditions which make driving more difficult? 4. A backing aid system helps the driver back up by providing sounds, lights, or symbols when the vehicle is near an obstacle. Does your vehicle have a system like this? 4A. If no, then why not? 4B. If you purchased this same vehicle again would you want the backing aid system? (for those who do not currently have a backing aid system) 6. Approximately how many miles have you personally driven this vehicle?
Acceptance	5. If you purchased this same vehicle again would you want the backing aid system? (for those who currently have a backing aid system)
Learning	7. How did you learn to use your vehicle's backing aid system? 9. How easy was it to learn how to use your vehicle's backing aid system to judge the distance to objects behind your vehicle? 10. Were there things that were especially difficult to learn about your vehicle's backing aid system? 10A. If yes, please explain.

Behavioral Adaptation to System	11. In the last two weeks, did you ever use just the backing aid system when backing without checking the mirrors or turning to look out the rear view window? 12. Imagine that your vehicle's backing aid system broke down. How would your driving behavior change if you could not use your vehicle's backing aid system? 18C. When I use the backing aid, I use my mirrors less often than I would if I did not have the backing aid (strongly disagree, disagree, neutral, agree, strongly agree, not applicable). 18D. When I use the backing aid, I look over my shoulder less often than I would if I did not have the backing aid (strongly disagree, disagree, neutral, agree, strongly agree, not applicable). 18E. I am more confident in my ability to detect pedestrians when I use the backing aid (strongly disagree, disagree, neutral, agree, strongly agree, not applicable). 18F. I am more willing to park in small or difficult parking spaces when I use the backing aid (strongly disagree, disagree, neutral, agree, strongly agree, not applicable). 19. How has your reliance on the backing aid system changed since you first got the vehicle?
Perceived Effectiveness	13. Please rate how well the backing aid would assist you in avoiding a collision under the following circumstances: 13A. You are slowing backing out of a driveway into the street. There is a car that you can't see approaching on the street as you begin to back into its path. 13B. You are backing quickly down a long driveway, going about 10 mph. There is a bicycle behind you that you didn't see. 13C. You begin to back out of a garage and there is a child immediately under the rear bumper. 13D. You are slowly backing out of a parking space and there is a pedestrian standing 10 feet behind your rear bumper. 13E. You are backing up to a narrow sign post. 13F. You are backing into a parallel parking space. The space is tight and you have to back very close to the car behind you. 14. How well does your vehicle's backing aid system work in the following weather conditions? 14A. Darkness 14B. Fog 14C. Cold temperatures 14D. Rain 14E. Snow 14F. Bright sun 14G. Are there any other conditions under which your vehicle's backing aid system does not work well? 18G. The backing aid gives me a good idea of my distance from an obstacle (strongly disagree, disagree, neutral, agree, strongly agree, not applicable). 18H. The backing aid gives alerts with enough time to avoid hitting an obstacle (strongly disagree, disagree, neutral, agree, strongly agree, not applicable). 18I. The backing aid gives too many false warnings when I am not in danger of hitting anything (strongly disagree, disagree, neutral, agree, strongly agree, not applicable). 18J. The backing aid fails to warn me about an obstacle when it should have (strongly disagree, disagree, neutral, agree, strongly agree, not applicable). 22. Suppose the diagram below shows an overhead view of your vehicle. Based on your experience, write an "X" in all rectangles where you think your backing aid system would detect a small child and give you a warning. (diagram shown)
User Interface and Usability	15. If your vehicle's backing aid system has both lights/symbols and sounds, which do you rely on more? 18A. It's easy to hear the sounds made by the backing aid system (strongly disagree, disagree, neutral, agree, strongly agree, not applicable). 18B. It's easy to see the lights/symbols on the backing aid system (strongly disagree, disagree, neutral, agree, strongly agree, not applicable).
Safety	8. Are you aware of any warnings or limitations related to your vehicle's backing aid system? 8A. If yes, please explain.

	16. Have you ever unintentionally backed into something or had a "close call" since you started driving this vehicle? 16A. If yes, please describe the situation. 17. Since you have owned this vehicle, have you driven another vehicle without a backing aid system and backed into something or had a "close call" because you expected the vehicle to give you a warning? 20. Have you ever received an unexpected warning when backing because you didn't know what was behind your vehicle? 20A. If yes, then how did you react the last time this happened? 20B. If yes, what was the reason for the last unexpected warning? 21. Overall, does having the backing aid system make you a safer driver? 23. Does using the backing aid create any new driving problems or safety concerns for you? 23A. If yes, please explain.
Need for Improvements	24. Is there anything about the way that the backing aid system works that you think should be improved? 24A. If yes, please explain. 25. In general, do you believe that car manufacturers are doing enough to design vehicles to accommodate an aging population? 25A. If you answered "no," then what more do you believe could be done?

Table 3. Rear-view camera questionnaire: Content areas and associated items

Background	1. Age 2. Gender 3. Do you have any physical conditions which make driving difficult? 4. A rear-view video camera shows the driver the area behind the vehicle on a screen inside the vehicle when you are backing on a screen inside the vehicle. Does your vehicle have a rear-view video camera? 4A. If no, then why not? 4B. If you purchased the same model vehicle again would you want a rear-view camera? (for those who do not currently have a camera) 6. Approximately how many miles have you personally driven this vehicle?
Acceptance	5. If you purchased this same model again would you want a rear-view camera? (for those who currently have a camera)
Learning	7. How did you learn to use your vehicle's rear-view camera? 9. How easy was it to learn how to use your vehicle's rear-view camera to judge the distance to objects behind your vehicle? 10. Were there things that were especially difficult to learn about your vehicle's rear-view camera? 10A. If yes, please explain.
Behavioral Adaptation to System	11. In the last two weeks, did you ever use just the camera when backing without checking the mirrors or turning to look out the rear window? 12. Which of the following best describes how much you would normally pay attention to the rear-view camera when backing? 13. Imagine that your vehicle's rear-view camera broke down. How would your driving behavior change if you could not use your vehicle's rear-view camera anymore? 17. How has your usage of the rear-view camera changed since you first got the vehicle? 19B. I am more confident in my backing abilities when I use the rear-view camera (strongly disagree, disagree, neutral, agree, strongly agree). 19C. I am more willing to park in small or difficult parking spaces when I use the rear-view camera (strongly disagree, disagree, neutral, agree, strongly agree).
Perceived Effectiveness	15. How well does your vehicle's rear-view camera work in the following weather conditions? 15A. Darkness 15B. Fog

	15C. Cold temperatures 15D. Rain 15E. Snow 15F. Bright sun 15G. Are there any other weather conditions where your vehicle's rear-view camera does not work well? 18. Suppose that the diagram below shows an overhead view of your vehicle and areas labeled "A"- "Q". Based on your experience, please circle the letters for all areas where your rear-view camera would show you obstacles such as a small child sitting on the ground (diagram shown).
User Interface and Usability	14. If your vehicle's rear-view camera display has lines, graphics, or text information on the screen, do you find these useful? 16. Overall, how easy is the rear-view camera to use when backing out of a driveway? 19A. The rear-view camera is in a location where it is easy to see when I am backing (strongly disagree, disagree, neutral, agree, strongly agree). 19D. It's easy to tell how close I am to an obstacle by looking at the rear-view camera display (strongly disagree, disagree, neutral, agree, strongly agree). 19E. The rear-view camera does not show the entire area behind the vehicle that I need to see when backing, in other words there is a blind spot (strongly disagree, disagree, neutral, agree, strongly agree). 19F. The rear-view camera display gets blurry or hard to see if I am moving (strongly disagree, disagree, neutral, agree, strongly agree). 19G. The rear-view camera gets dirty and makes obstacles hard to see (strongly disagree, disagree, neutral, agree, strongly agree). 19H. Sun glare on the video display makes it hard for me to see objects or people (strongly disagree, disagree, neutral, agree, strongly agree). 19I. It's hard to distinguish something or someone who may be in the shadow area behind my vehicle (image contrast level is poor in the camera) (strongly disagree, disagree, neutral, agree, strongly agree).
Safety	8. Are you aware of any warnings or limitations about your vehicle's rear-view camera? 8A. If yes, please explain. 19J. My risk of hitting somebody while backing is lower with the rear-view camera than without it (strongly disagree, disagree, neutral, agree, strongly agree). 20. Have you ever unintentionally backed into something or had a "close call" since you started driving this vehicle? 20A. If yes, were you using the camera at the time? Please describe the situation. 21. Does using the rear-view camera create any new driving problems or safety concerns for you? 21A. If yes, please explain. 22. Overall, does having the rear-view camera make you a safer driver?
Need for Improvements	23. Is there anything about the rear-view camera that you think should be improved? 23A. If yes, please explain. 24. In general, do you believe that car manufacturers are doing enough to design their vehicles to accommodate an aging population? 24A. If you answered "no" then what more do you believe could be done?

The questionnaires were 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. (Both the backing aid questionnaire and rear-view camera questionnaire are included in Appendix A.)

For each technology survey the draft questionnaire was pilot-tested in two stages. First, the questionnaire was administered to a small sample of Westat, Inc. and NHTSA employees who were asked to record the amount of time that it took them to complete the questionnaire and to note any items that they did not understand or thought were unclear. If problems with specific items were uncovered, the wording of these items was changed to improve understanding.

A second stage of pilot tests was conducted by mailing out 100 questionnaires to drivers insured through the Automobile Club of Southern California. Seventy-five percent of the pilot questionnaires for each survey were mailed to vehicle owners whose vehicle included the 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. Also, half of the questionnaires were mailed to vehicle owners who are 65 years old or older, and the other half of the questionnaires were mailed to vehicle owners who are 25 to 64 years old. This mail-out was used to get an indication of the expected response rate for the survey and to review the types of answers that respondents provided to ensure that each item was understandable. Based on these responses some minor changes to the questionnaires were made. Next steps in this project included collaborating with project partners to finalize all of the survey instruments and mailing out the questionnaires to ACSC insurance customers. Questionnaires for the backing aid survey and the rear-view camera survey were mailed out during July 2006. A cover letter from ACSC was included that explained the purpose of the survey and invited the vehicle owners to participate (see Appendix A). All vehicle owners who received questionnaires were asked to return the questionnaires even if they did not have the indicated technology on their vehicles. 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 vehicle. 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 telephone interviews. ACSC staff only called system owners who indicated on the written questionnaire that they thought that their backing aid or rear-view camera 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 D). Forty-two owners of backing aid systems and 46 owners of rear-view cameras were interviewed. The interviewees' comments are given in Appendix E (backing aid owners) and Appendix F (rear-view camera owners). 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 the 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 backing aids or rear-view cameras as standard or optional equipment. It is important to note that the resulting list of vehicle owners represents possible (but not certain) system owners. Based on

ACSC records, there was no way to know if the vehicle owner had actually purchased optional equipment.

Backing aid questionnaires (n = 5,000) and rear-view camera questionnaires (n = 5,000) 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 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. An additional sampling requirement was that, to the extent possible, one-half of the questionnaires for each technology survey were mailed to vehicle owners aged 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.

Data Reduction and Data Analysis

Participants returned their completed questionnaires in self-addressed, postage-paid envelopes to ACSC, where the envelopes were opened and the front page of the questionnaire was removed. This page contained the respondent's name, address, and whether they were willing to be contacted by ACSC for a brief follow-up telephone interview. Returned questionnaires (minus the front page) were then sorted by technology type and shipped in batches to Westat, Inc. for further processing. At this point, the completed questionnaires contained no personally identifying information except for a unique ID number. Westat, Inc. staff coded questionnaire responses, entered the data into a database, and created SAS data files to be used for subsequent statistical analyses. Frequencies (and percentages) for each response type were computed for each item on the questionnaires. The complete set of response frequencies for the backing aid survey is provided in Appendix B and the complete set of response frequencies for the rear-view camera survey is provided in Appendix C.

For open-ended items, Westat, Inc. staff developed several response category codes to capture the most common responses received. An "other" category was used to code low-frequency responses. For certain survey items that were included on the backing aid questionnaire and the rear-view camera questionnaire, responses were compared across technology types or responses were combined as appropriate.

Responses from drivers aged 65 years old or older were compared to responses from drivers who were younger than 65 years, and the responses from owners of different makes of vehicle were also compared. Vehicle manufacturers for which there were few respondents were excluded from the statistical comparisons.

RESULTS

Tabulated response frequencies for all survey items are show in Appendix B (for backing aid systems) and Appendix C (for rear-view cameras). In this section, results from both surveys are described. In interpreting the results, particularly with respect to comparisons between backing aids and rear-view cameras, it is important to note that the respondents to the backing aid survey differed in several ways from those who responded to the rear-view camera survey. For example, the age and gender distributions for respondents who reported having sensor-based backing aid systems are different from those who reported having rear-view cameras. Because questionnaires were mailed only to owners of vehicles likely to have a particular type of in-vehicle technology, the vehicle manufacturers and models represented by the two samples differ. Respondents with backing aid systems had vehicles from the 2001 to 2006 model years, while nearly all respondents to the rear-view camera survey had vehicles from the 2003 to 2006 model years. As a group, the rear-view camera owners had less experience driving their vehicles (i.e., reported having driven fewer miles) than did the owners of backing aids. Also, information about vehicles from many more vehicle manufacturers is represented in the backing aid sample than in the rear-view camera sample. Respondents with rear-view cameras had vehicles from only five manufacturers, while respondents with backing aid systems had vehicles from 21 manufacturers.

All system owners' data (from all vehicle manufacturers) were used for the majority of the analyses reported here. However, due to the small sample size obtained for some manufacturers, we restricted comparisons between manufacturers to those with adequate data in our samples. Thus, only data from respondents who owned backing aids on vehicles manufactured by BMW, Buick, Cadillac, Ford, Jaguar, Lincoln, Nissan, and Toyota, or rear-view cameras on vehicles manufactured by Acura, Infiniti, and Lexus were used in analyses that included vehicle manufacturer as an analysis variable.

1. General Characteristics of Survey Respondents

Response rate

Vehicle owners selected for either the backing aid survey or the rear-view camera survey were instructed to return the questionnaire even if they did not have the technology on their vehicles. For the backing aid survey, 1,537 of 5,000 questionnaires were returned (30.7%). For the rear-view camera survey, 1,481 of 5,000 questionnaires were returned (29.6%). Approximately 71 percent of those who returned the backing aid questionnaire reported having backing aid systems, and approximately 72 percent of those who returned the rear-view camera questionnaire reported having rear-view cameras. Some additional questionnaires (26 backing aid and 28 rear-view camera) were received by ACSC in the months following the cut-off date for data analysis and were not included in the results reported here.

Age and gender

Figures 5 and 6 show the number of respondents in each of six age categories who have backing aid systems or rear-view cameras. The dark part of each bar represents the number of men and the lighter part of each bar represents the number of women. The age distribution

for respondents who reported that they have backing aid systems differs significantly from the age distribution for respondents who reported that they have rear-view cameras, χ^2 (5) = 442.0, $p < .001$. The respondents with backing aid systems tended to be older (median age = 69) than the respondents with rear-view cameras (median age = 51).

The sample of backing aid respondents and the sample of rear-view camera respondents differ significantly with respect to gender, χ^2 (1) = 17.0, $p < .001$. Approximately 38 percent of the respondents who reported owning backing aid systems are women, while 47 percent of the respondents who own rear-view cameras are women. Among those who have one of the assistive backing technologies on their vehicle, the proportion of female respondents decreases with age in a similar manner for the backing aid system survey and for the rear-view camera survey (see Table 4).

Table 4. Proportion of female respondents by age category

	18 to 34 years	35 to 44 years	45 to 54 years	55 to 64 years	65 to 74 years	75 years or older
Backing aid system	.65	.58	.42	.44	.36	.28
Rear-view Camera	.67	.58	.47	.43	.32	.29

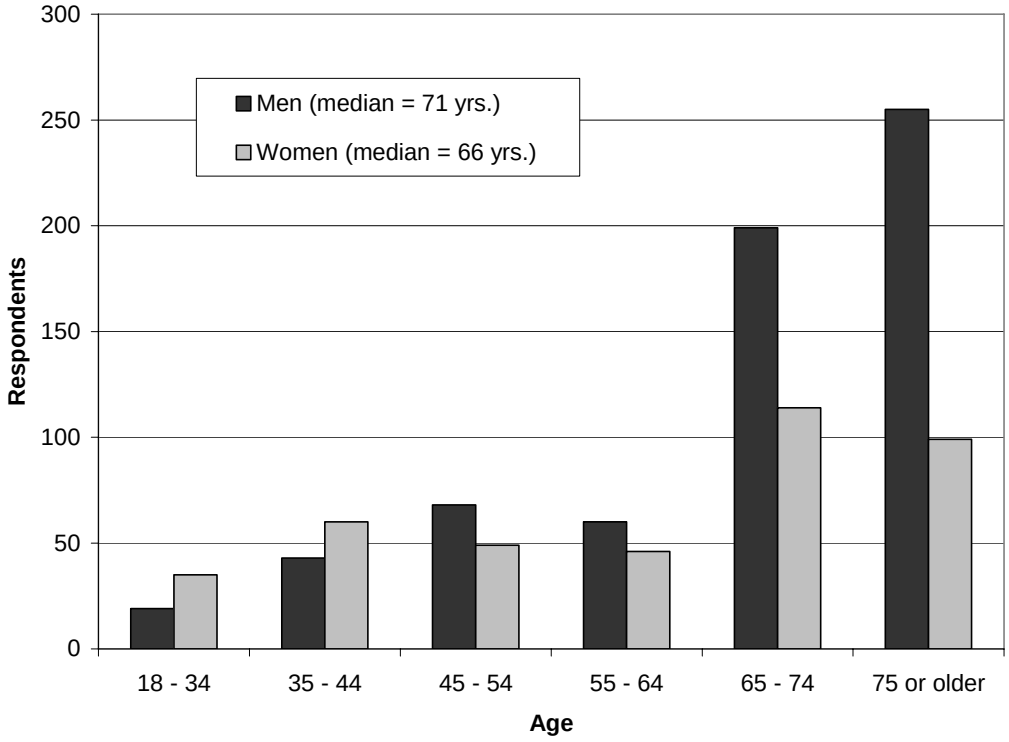


Figure 5. Age and gender of respondents who have backing aid systems

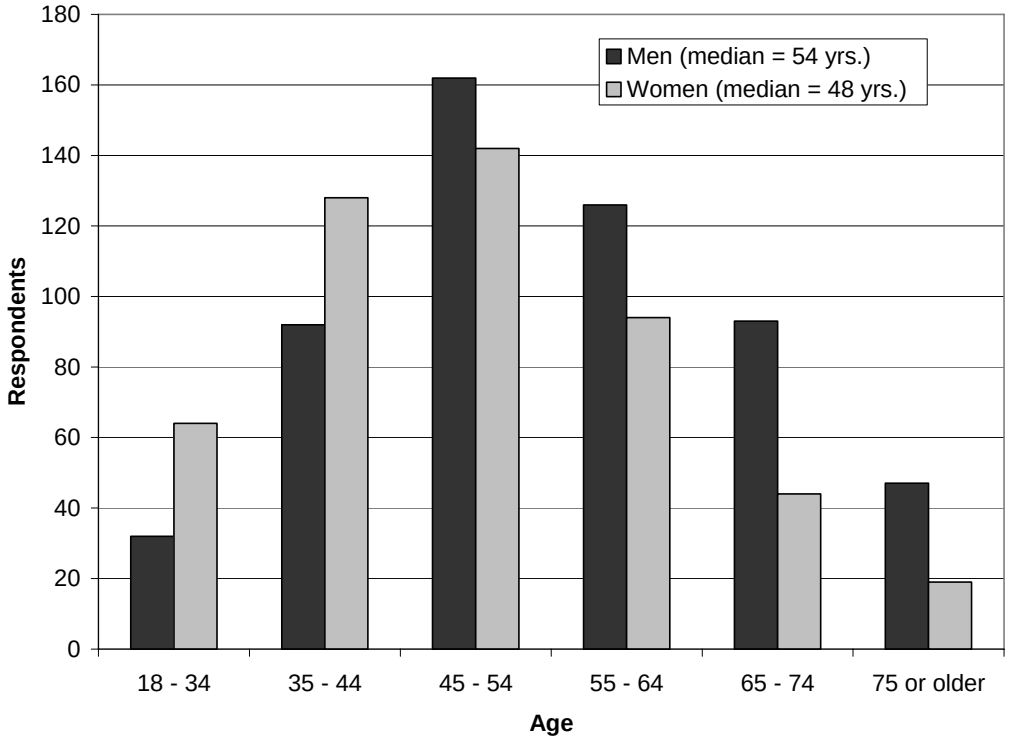


Figure 6. Age and gender of respondents who have rear-view camera systems

Physical conditions that make driving more difficult

On both the backing aid questionnaire and rear-view camera questionnaire respondents were asked, (Q3): "Do you have any physical conditions which make driving more difficult?" Given the difference in age distributions for the backing aid respondents and the rear-view camera respondents, we expected that a larger percentage of backing aid respondents would have physical conditions that make driving difficult. In fact, owners of backing aid systems reported vision problems, hearing problems, and difficulty turning head/neck more frequently than owners of rear-view cameras. Hearing problems, in particular, were reported by 6.25 percent of backing aid owners, but only by 0.82 percent of camera owners. This difference may be related to the older age distribution for respondents to the backing aid survey (median age = 69) as compared to the camera survey (median age = 51).

In general, older respondents reported more physical conditions than younger respondents. Nine percent of all respondents to the backing aid survey who were 65 or older reported hearing problems, but only a single person (0.3%) who was younger than 65 reported a hearing problem. Hearing problems were also reported by five (2.7%) rear-view camera owners who were 65 or older and by two (0.3%) owners younger than 65.

Among respondents who are younger than 65 years old, "difficulty turning my head/neck" was reported by 3.4 percent of backing aid owners and 2.5 percent of rear-view camera owners. Among those respondents age 65 or older, 8.6 percent of backing aid owners and 4.8 percent of rear-view camera owners had this problem.

Among respondents who are younger than 65 years old, vision problems were reported by 3.1 percent of owners of backing aids and by 3.7 percent of rear-view cameras. Among those age 65 or older, 6.8 percent of backing aid owners and only 2.7 percent of rear-view camera owners reported vision problems.

Approximately 84 percent of those with backing aid systems and 94 percent of those with rear-view camera systems indicated that they had no physical conditions that would make driving more difficult.

During the telephone interviews, some respondents noted how the backing aid system or rear-view camera helped support their driving abilities:

> *"The [backing aid system] is there as an assistant; it gives additional input to your own senses and abilities." (Male, 84)*
>
> *"I haven't really changed my driving habits, I still look back before backing but when my arthritis flairs up I depend on the [rear-view] camera more. (Female, 62)*
>
> *"I have periodic neck problems that make it painful to fully turn my neck and this [rear-view camera] is very helpful." (Male, 49)*

Driving experience with currently owned vehicle

On each of the in-vehicle technology questionnaires vehicle owners were asked to write-in the number of miles they had driven their vehicles. This item (Q6) was used as a surrogate measure of experience with the vehicles and their associated in-vehicle technology. For analysis purposes, responses were grouped in mileage (experience) categories. Table 5 shows the distribution of experience levels for male and female owners of rear-view cameras who

responded to the survey. Experience is distributed differently for male and female camera owners $\chi^2(4) = 12.6$, $p < .05$. Among those with little experience (<10,000 miles) a higher proportion were men and among those with greater experience (20,000 miles or more) a higher proportion were women. For respondents who own backing aid systems, experience was not significantly related to gender $\chi^2(4) = .35$, $p = .98$.

Table 5. Respondents who have rear-view camera systems by gender 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
Male	95 17.86 (61.69)	99 18.61 (53.80)	197 37.03 (56.29)	77 14.47 (45.56)	64 12.03 (46.04)	532 (53.41)
Female	59 12.72 (38.31)	85 18.32 (46.20)	153 32.97 (43.71)	92 19.83 (54.44)	75 16.16 (53.96)	464 (46.59)
Total	154 15.46	184 18.47	350 35.14	169 16.97	139 13.96	996 100.00

Given the greater range of (older) model years for vehicles owned by respondents to the backing aid survey as compared to the rear-view camera survey, we expected that rear-view camera owners as a group would have more experience with their vehicles. The distributions of experience for backing aid survey respondents and rear-view camera survey respondents are compared in Figure 7. Experience was distributed differently for backing aid and camera respondents $\chi^2(4) = 30.5$, $p < .001$. As expected, a greater proportion of respondents with backing aids reported higher levels of experience than did respondents with a rear-view camera and the median number of miles driven by those with backing aid systems (15,000 miles) was higher than the median miles driven by those with rear-view camera systems (12,000 miles).

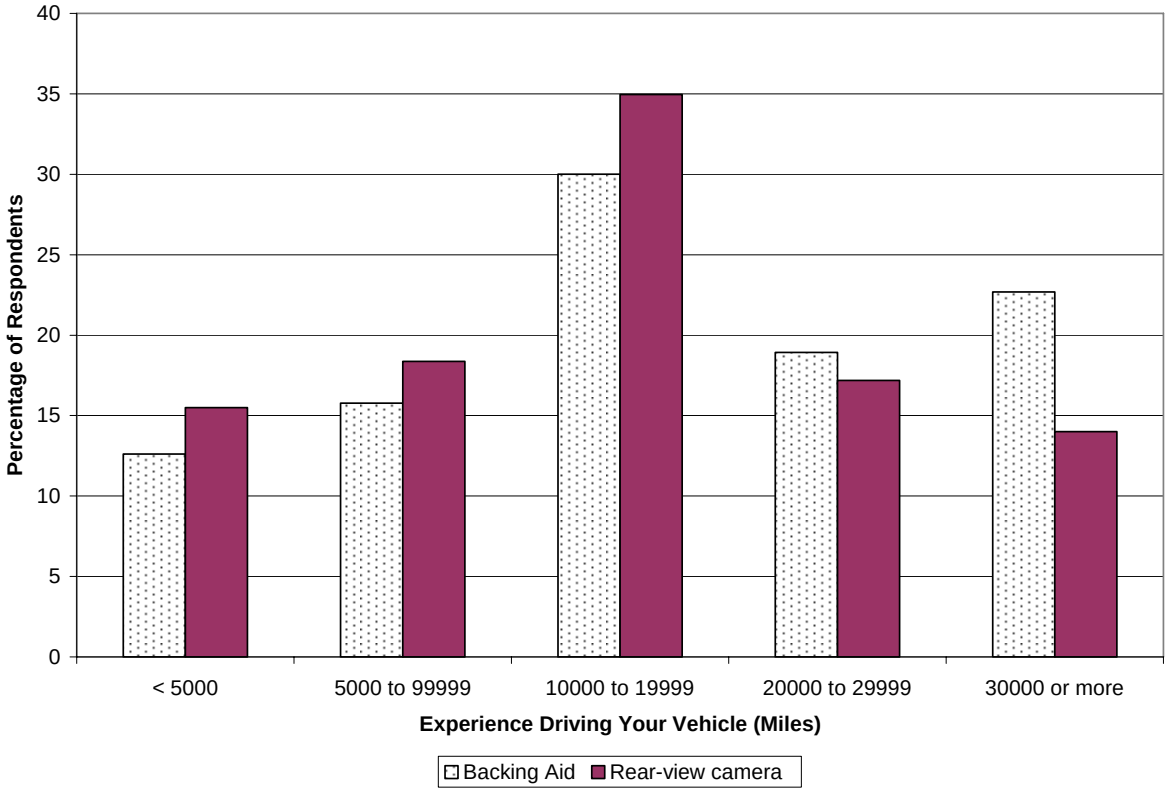


Figure 7. Experience driving current vehicle with a backing aid system or rear-view camera

2. Desire to Have Backing Aid Systems and Rear-View Cameras

On the backing aid questionnaire there were two identical questions targeted to respondents who currently have (Q5) or do not have (Q4B) the systems: "If you purchased this same vehicle again would you want a backing aid system?" Two similar items on the rear-view camera questionnaire asked respondents if they would want a rear-view camera. The response frequencies for these items are shown in Table 6. It is clear from these data that respondents are generally satisfied with their systems as the vast majority of system owners would want to purchase their backing systems (98%) or rear-view cameras (93%) again.

For respondents who currently have either backing aid systems or rear-view cameras, the pattern of responses to item Q5 depended on the type of system that they have $\chi^2(2) = 35.97$, $p < .001$. A higher percentage of those with the backing aid systems would want to get the systems again as compared to those with rear-view cameras. For respondents who do not currently have backing aid systems or rear-view cameras, the pattern of responses to item Q4B did not differ significantly with the type of system that they were asked about $\chi^2(2) = 5.52$, $p = .063$. Approximately half of the respondents who do not have systems would want to get them if they purchased their same vehicles again, and approximately a third of the respondents did not know whether they would want the systems or not.

Table 6. Respondents who would want backing aid systems (or rear-view cameras) if they purchased their same vehicles again

Frequency Row Pct.	Yes	No	Don't Know	Total
Respondents who have backing aids now (Q5)	1,048 98.3	9 0.84	9 0.84	1,066 100.00
Respondents who do not have backing aids (Q4B)	227 51.95	76 17.39	134 30.66	437 100.00
Respondents who have rear-view cameras now (Q5)	938 93.18	22 2.09	50 4.74	1,010 100.00
Respondents who do not have rear-view cameras (Q4B)	177 44.58	90 22.67	130 32.75	397 100.00

Respondents who do not currently have backing systems or rear-view cameras were asked why they didn't have it (item Q4A). The two most common reasons cited for not having both the backing aid system and the rear-view camera were related to lack of knowledge about the system and/or availability of the system. Approximately half (49%) of the backing aid respondents and a third (34%) of the rear-view camera respondents indicated that "it never occurred to me to look for one when I was buying the vehicle." Approximately 59 percent of backing aid respondents and 43 percent of rear-view camera respondents indicated that "it was not an option on my vehicle." Relatively few respondents cited cost (9%) and bundling with other unwanted options (9%) as reasons for not having a backing aid system. On the other hand, the rear-view camera, which is often sold as an option bundled with a navigation system, was not obtained by 21 percent of respondents because of cost and because of bundling with other unwanted options (19%). Approximately 13 percent of the backing aid respondents and 9 percent of the rear-view camera respondents thought that they "don't need the system because I have good backing skills." Fewer respondents (3 to 6%) thought that the system "would be a nuisance or distraction" or that they "wouldn't trust" the system. The complete list of response frequencies for these items is shown in the appendices.

3. Learning to Use the Technology

Both the backing aid survey and the rear-view camera survey had similar patterns of results regarding how owners learned to use their systems (Q7). The most frequently reported methods were "on-road experience and practice (trial and error)" and "instructions from the dealership . . ." Only three percent reported receiving help from a friend or relative, and approximately one percent used "information on the Internet." The vehicle owner's manual was used by 43 percent of respondents with backing aids and 32 percent of those with rear-view cameras.

No statistically significant differences were found between manufacturers in the frequencies of learning methods cited by rear-view camera owners (see Appendix C). However, the response frequencies for two of the learning methods used by backing aid owners depended on the owner's vehicle manufacturer. In Table 7, the row labeled "Yes" shows the number of respondents who checked a box on the backing aid questionnaire item Q7A to indicate that they had used "instructions from the dealership, such as a video, brochure, or demonstration"

to learn to use their backing aid systems. The number of respondents to Q7 who did not select this response choice is shown in the row labeled "No." The response frequencies are tabulated for the eight most common vehicle manufacturers in the sample. The table shows that this learning method was used by approximately 36 percent of Jaguar owners and 58 percent of Buick owners. Differences between manufacturers in the proportions of respondents who used this learning method were statistically significant, $\chi^2(7) = 18.57$, $p < .01$.

Table 7. Respondents who learned to use their backing aids from "instructions from the dealership . . ." by vehicle manufacturer

Frequency Row Pct. (Col. Pct.)	BMW	Buick	Cadillac	Ford	Jaguar	Lincoln	Nissan	Toyota	Total
Yes	18 4.34 (42.86)	29 6.99 (58.00)	129 31.08 (53.53)	58 13.98 (45.31)	67 16.14 (35.83)	77 18.55 (40.53)	14 3.37 (42.42)	23 5.54 (44.23)	415 (44.96)
No	24 4.72 (57.14)	21 4.13 (42.00)	112 22.05 (46.47)	70 13.78 (54.69)	120 23.62 (64.17)	113 22.24 (59.47)	19 3.74 (57.58)	29 5.71 (55.77)	508 (55.04)
Total	42 4.55	50 5.42	241 26.11	128 13.87	187 20.26	190 20.59	33 3.58	52 5.63	923 100.00

In Table 8, the row labeled "Yes" shows the number of respondents who indicated that they had relied upon "on-road experience and practice (trial and error)" to learn to use their backing aid systems (Q7E). The table shows that this leaning method was used by approximately 75 percent of Toyota owners and only 34 percent of Buick owners. Differences between manufacturers in the proportions of respondents who used this learning method were statistically significant, $\chi^2(7) = 31.57$, $p < .001$.

Of the 1,037 respondents with backing aid systems who answered item Q7, 28 percent indicated only "on-road experience and practice (trial and error)" as the learning method that they used. A similar result was found on the rear-view camera survey. Of the 1,047 respondents with rear-view cameras who answered item Q7, 31 percent reported only "on-road experience . . ." as their learning method.

Table 8. Respondents who learned to use their backing aids from "on-road experience and practice (trial and error)" by vehicle manufacturer

Frequency Row Pct. (Col. Pct.)	BMW	Buick	Cadillac	Ford	Jaguar	Lincoln	Nissan	Toyota	Total
Yes	23 4.63 (54.76)	17 3.42 (34.00)	109 21.93 (45.23)	81 16.30 (63.28)	100 20.12 (53.48)	106 21.33 (55.79)	22 4.43 (66.67)	39 7.85 (75.00)	497 (53.85)
No	19 4.46 (45.24)	33 7.75 (66.00)	132 30.99 (54.77)	47 11.03 (36.72)	87 20.42 (46.52)	84 19.72 (44.21)	11 2.58 (33.33)	13 3.05 (25.00)	426 (46.15)
Total	42 4.55	50 5.42	241 26.11	128 13.87	187 20.26	190 20.59	33 3.58	52 5.63	923 100.00

4. Behavioral Adaptation

Use of technology over time

Owners of backing aid systems were asked how their "reliance" on the systems has changed since they first got their vehicles (Q19). Similarly, rear-view camera owners were asked how their "usage" of the cameras has changed since they first got their vehicles (Q17). The proportion of respondents who said that they rely on the backing aid systems "more now than I did in the beginning" was 35.5 percent overall, but increased systematically with level of vehicle experience from 21 percent for the lowest experience group to 45 percent in the highest experience group, possibly indicating that as drivers gain more experience with the systems they tend to rely on it more. Overall, very few respondents (1.2%) said that they rely on the backing aid system less now than they did in the beginning. As compared to the other responses, the differences between experience levels for the proportion of backing aid owners who said that they "rely on it more now" are statistically significant $\chi^2(4) = 19.0$, $p < .001$. These results are shown in Figure 8.

For the rear-view camera system, the proportion of respondents who said that they use their cameras more now than in the beginning overall was 40.5 percent. Few respondents (3 %) said that they use the camera less now than they did in the beginning. The pattern of responses for this item did not depend significantly on experience $\chi^2(8) = 9.5$, $p = .30$.

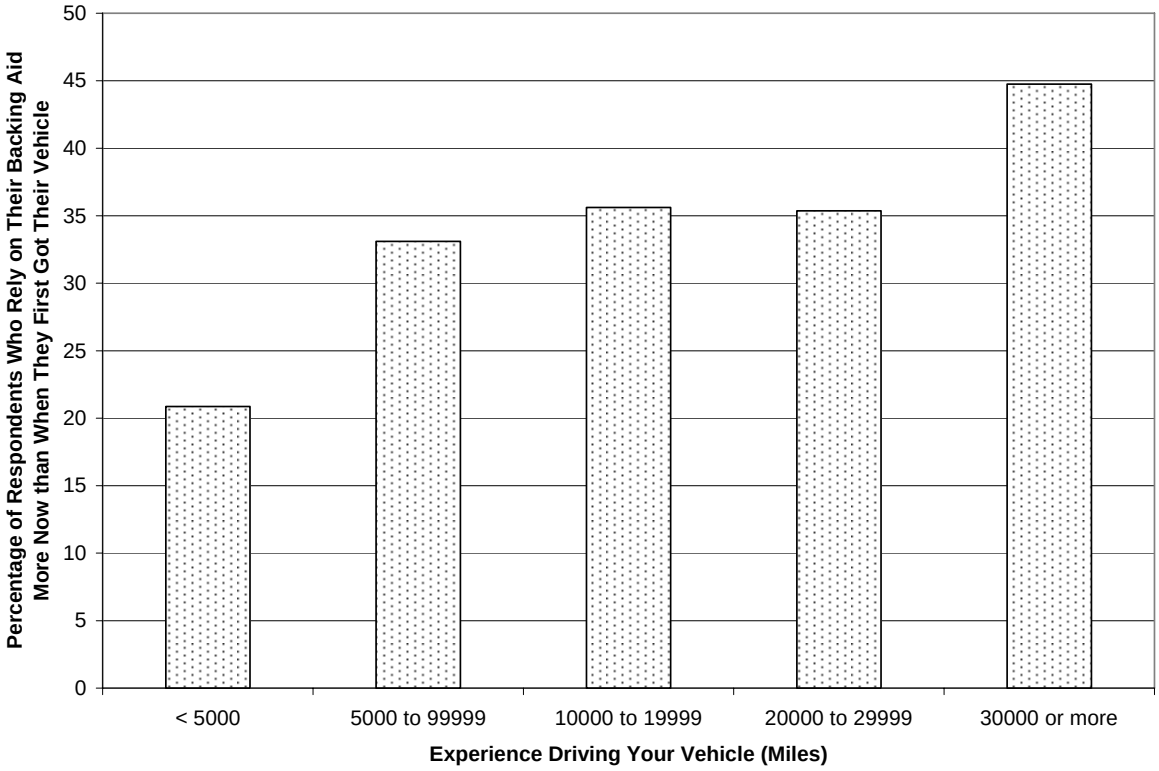


Figure 8. Backing aid owners who "rely on their systems more now" by experience level

How backing behaviors would be different without the technology

Another item that was on both the rear-view camera survey (Q13) and the backing aid survey (Q12) asked system owners to imagine that their vehicle's rear-view camera (backing aid system) broke down: "How would your driving behavior change if you could not use your vehicle's (rear-view camera / backing aid system)?" The percentage of respondents who said that they would rely more on their mirrors and /or glances over their shoulder (approximately 61%) was nearly the same for both owners of rear-view camera and owners of backing aid systems, although it was significantly higher for backing aid owners who were 65 years or older (65.8 %) as compared to younger backing aid owners (51.3%) $\chi^2(1) = 21.2$, $p < .001$. The percentage of respondents who said that their driving behavior would not change (30 to 35%) also was similar for owners of the two systems, as was the percentage of respondents who said that they would not try to fit into tight parking spaces (13 to 17%). A large difference was observed for the response, "I would back up much more slowly." Approximately 40 percent of backing aid owners selected this statement, but only 27 percent of rear-view camera owners selected this statement. Also, backing aid owners more frequently said that they would avoid parking spaces where they would have to back up (9.0 %) as compared to rear-view camera owners (4.7%).

None of the responses to this item on the rear-view camera survey depended significantly on respondents' level of experience with their vehicle. However, the results for two of the response choices for this item on the backing aid survey varied with experience level. The percentage of respondents who said that they would not try to fit into tight parking spaces if

their backing aid systems were broken depended significantly on experience, $\chi^2(4) = 17.4$, $p < .01$, and increased from 8.9 percent for those with less than 5,000 miles of experience to 23.5 percent for those with 30,000 or more miles of experience. These results are shown in Figure 9.

A similar pattern of results is shown in Figure 10. The percentage of backing aid owners who said that they would back up much more slowly also depended significantly on experience $\chi^2(4) = 12.1$, $p < .05$, and tended to increase with experience. Note that "backing up much more slowly" was selected approximately twice as frequently as "not trying to fit into tight parking spaces."

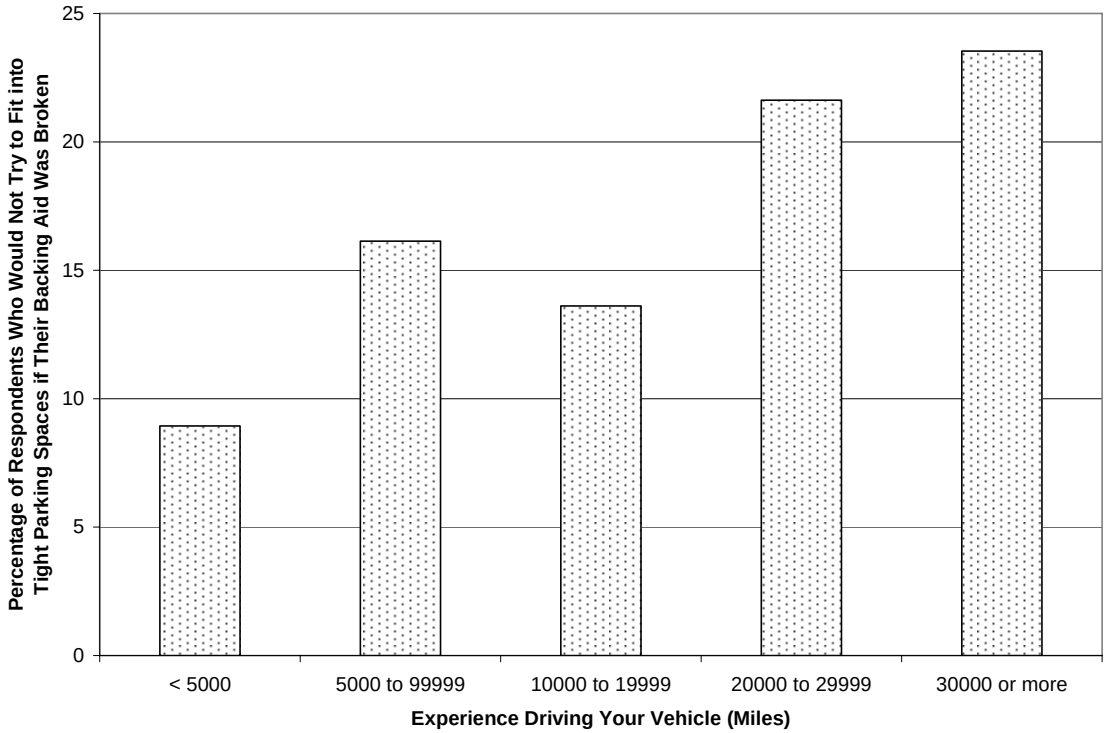


Figure 9. Those who would not try to fit into tight parking spaces without their backing aids

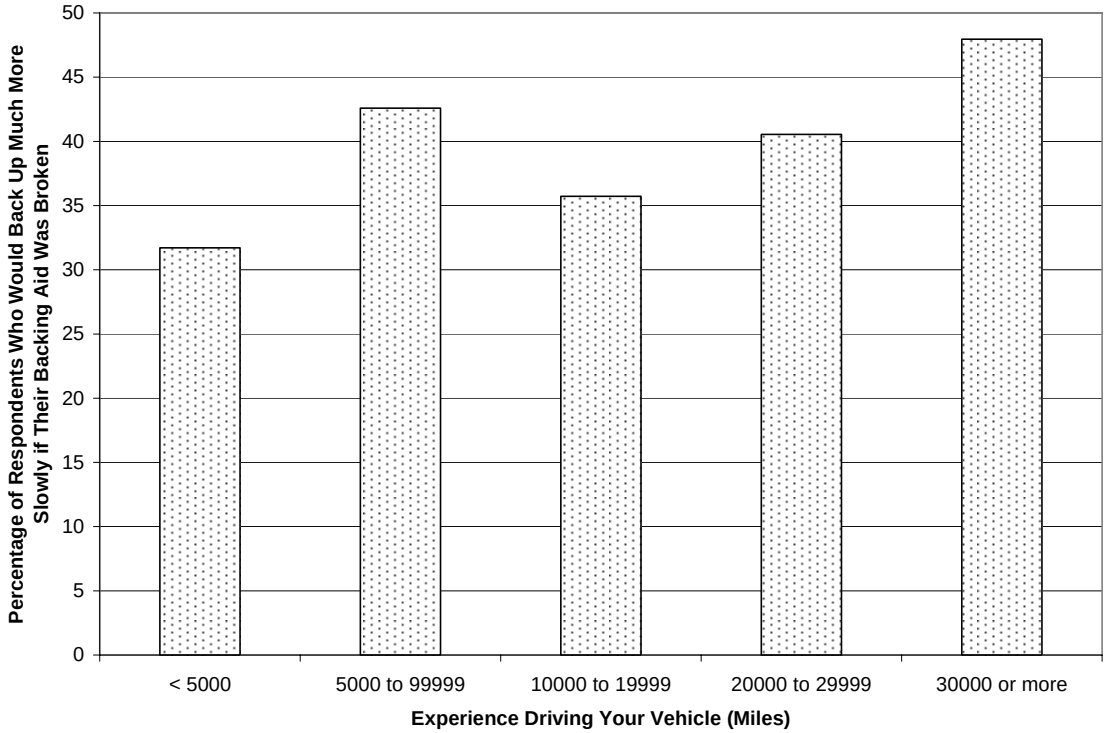


Figure 10. Those who would back up much more slowly without their backing aids

Reliance on technology

> *". . . you become too dependent on [the backing aid]. On a car without it, you lose your sense of distance. It took a few months to get used to it." – (Female, 36)*
>
> *"I changed my [driving] habits at first and the [camera] system made me really dependent on it. It gives you a false sense of security. It wasn't until I backed into the path of an oncoming car that I realized that I still have to use my mirrors and look over my shoulders when backing. I got used to it quickly and it took about six months before a couple of close calls changed my use of the camera." – (Male, 48)*
>
> *"I don't think the camera has changed my driving. I guess I'm old fashioned, I still look over my shoulders when backing up." – (Male, 72)*

Item Q11 on both surveys asked respondents whether, within the last two weeks, they had ever used just the backing aid system / rear-view camera when backing without checking their mirrors or turning to look out the rear view window. Approximately 17 percent of rear-view camera owners and 12 percent of backing aid system owners admitted that they had done this. Among rear-view camera owners (but not backing aid owners) the percentage of respondents who said "Yes" to this question was significantly higher for younger drivers (19.2%) than for those 65 years or older (10.3%), $\chi^2(1) = 9.27$, $p < .01$. No statistically significant differences for this item were observed between respondents with different levels of vehicle experience.

A related item (Q12) asked rear-view camera owners how much they normally pay attention to the rear-view camera when backing. The majority of respondents (67%) share their attention equally between the rear-view camera screen, mirrors, and direct glances out the rear window, although the proportion of respondents who said this was significantly different for those younger than age 65 (65.9%) as compared to those who were older (73.1%, $z = -2.07$, $p < .05$). Approximately seven percent of all respondents said that they pay attention to the camera screen more than to their mirrors or glances out the rear window. Younger participants (8.3%) were more than twice as likely as older participants (3.8%) to say this ($z = 12.67$, $p < .001$). Overall, 22 percent said that they usually just take a quick glance at the camera screen to determine if they can back up, and the proportion of older and younger respondents who said this did not differ significantly. No systematic differences were observed in the response frequencies for respondents with different levels of experience. The overall response frequencies for item Q12 are tabulated in Appendix C.

Four additional items (Q18C to Q18F) on the backing aid survey and two items (Q19B and Q19C) on the rear-view camera survey asked respondents how much they agree or disagree with statements related to their use of the backing technology. The results for all responses are tabulated in Appendix B and Appendix C. The percentage of respondents who either agreed or strongly agreed with each of these statements is shown in Table 9 by age group. Although some small differences in the proportion of younger and older respondents were observed, none of the age differences observed in Table 9 reached statistical significance except for item Q19C ($z = 2.21$, $p < .05$). However, when the full set of response categories (i.e., Strongly Disagree to Strongly Agree) is analyzed together, the distribution of responses for backing aid item Q18C depends significantly on age group $\chi^2(4) = 12.03$, $p < .05$, as does

the distribution of responses for Q18F, $\chi^2(4) = 12.00$, $p < .05$, and for rear-view camera item Q19C, $\chi^2(4) = 13.76$, $p < .01$.

Table 9. Behaviors related to backing aid system use and rear-view camera use by age group

Percentage of Respondents Who Agree or Strongly Agree With Statement	Younger than 65	65 or Older	All Respondents
Backing Aid System Survey Items			
Q18C: "When I use the backing aid I use my mirrors less often than I would if I did not have the backing aid."	21.22	17.03	18.58
Q18D: "When I use the backing aid I look over my shoulder less often than I would if I did not have the backing aid."	22.81	22.69	22.73
Q18E: "I am more confident in my ability to detect pedestrians when I use the backing aid."	67.47	70.95	69.66
Q18F: "I am more willing to park in small or difficult parking spaces when I use the backing aid."	50.00	44.18	46.34
Rear-View Camera Survey Items			
Q19B: "I am more confident in my backing abilities when I use the rear-view camera."	80.05	76.66	79.36
Q19C: "I am more willing to park in small or difficult parking spaces when I use the rear-view camera."	52.25	43.69	50.54

The responses to items Q18C, Q18F, Q19B and Q19C (but not Q18D and Q18E) are significantly related to level of experience with the vehicle (for Q18C, $\chi^2(16) = 31.6$, $p < .05$; for Q18F, $\chi^2(16) = 27.22$, $p < .05$; for Q19B $\chi^2(16) = 27.25$, $p < .05$; and for Q19C, $\chi^2(16) = 34.55$, $p < .01$). The responses to these items for different levels of experience are given in Table 10 through Table 13. For these items, the associations between experience level and proportion of (e.g., agree versus disagree) responses to these items generally suggest increased dependence or reliance on the technology at higher levels of experience. For item Q18C (use mirrors less often), the percentage of respondents who strongly disagree or disagree is lower for the backing aid owners with the most experience, and the percentage of those who strongly agree or agree is higher (Table 10).

For item Q19C, concerning willingness to park in small or difficult parking spaces, the proportion of "strongly agree" responses for rear-view camera owners increases with higher experience. The proportion of "neutral" responses decreases with higher experience (Table 13). For the same item on the backing aid survey (Q18F), the percentage of respondents who strongly disagree is lower for the two highest experience groups (Table 11). For item Q19B (concerning confidence in backing abilities) at higher levels of experience, a higher percentage of rear-view camera owners strongly agree with the statement as compared to respondents with lower levels of experience. At higher levels of experience respondents

tended to select “Agree” and “Neutral” at lower rates than did those with less experience (Table 12).

Table 10. Backing aid owners' response to item Q18C by level of 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 29,000 Miles	30,000 or More Miles	Total
Strongly Disagree	40 13.42 (33.90)	56 18.79 (38.36)	95 31.88 (33.93)	56 18.79 (31.11)	51 17.11 (23.61)	298 (31.70)
Disagree	48 13.52 (40.68)	50 14.08 (34.25)	102 28.73 (36.43)	72 20.28 (40.00)	83 23.38 (38.43)	355 (37.77)
Neutral	8 7.02 (6.78)	16 14.04 (10.96)	45 39.47 (16.07)	20 17.54 (11.11)	25 21.93 (11.57)	114 (12.13)
Agree	12 9.45 (10.17)	18 14.17 (12.33)	29 22.83 (10.36)	26 20.47 (14.44)	42 33.07 (19.44)	127 (13.51)
Strongly Agree	10 21.74 (8.47)	6 13.04 (4.11)	9 19.57 (3.21)	6 13.04 (3.33)	15 32.61 (6.94)	46 (4.89)
Total	118 12.55	146 15.53	280 29.79	180 19.15	216 22.98	940 100.00

Table 11. Backing aid owners' response to item Q18F by level of 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 29,000 Miles	30,000 or More Miles	Total
Strongly Disagree	13 13.00 (11.50)	21 21.00 (14.19)	34 34.00 (12.45)	14 14.00 (7.91)	18 18.00 (8.70)	100 (10.89)
Disagree	22 12.87 (19.47)	31 18.13 (20.95)	50 29.24 (18.32)	32 18.71 (18.08)	36 21.05 (17.39)	171 (18.63)
Neutral	23 10.45 (20.35)	40 18.18 (27.03)	79 35.91 (28.94)	37 16.82 (20.90)	41 18.64 (19.81)	220 (23.97)
Agree	30 12.93 (26.55)	26 11.21 (17.57)	69 29.74 (25.27)	54 23.28 (30.51)	53 22.84 (25.60)	232 (25.27)
Strongly Agree	25 12.82 (22.12)	30 15.38 (20.27)	41 21.03 (15.02)	40 20.51 (22.60)	59 30.26 (28.50)	195 (21.24)
Total	113 12.31	148 16.12	273 29.74	177 19.28	207 22.55	918 100.00

Table 12. Rear-view camera owners' response to item Q19B by level of 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
Strongly Disagree	6 35.29 (4.00)	2 11.76 (1.12)	6 35.29 (1.73)	0 0.00 (0.00)	3 17.65 (2.26)	17 (1.74)
Disagree	7 16.28 (4.67)	11 25.58 (6.15)	12 27.91 (3.47)	5 11.63 (2.92)	8 18.60 (6.02)	43 (4.39)
Neutral	28 19.05 (18.67)	32 21.77 (17.88)	44 29.93 (12.72)	26 17.69 (15.20)	17 11.56 (12.78)	147 (15.02)
Agree	61 16.62 (40.67)	73 19.89 (40.78)	133 36.24 (38.44)	58 15.80 (33.92)	42 11.44 (31.58)	367 (37.49)
Strongly Agree	48 11.85 (32.00)	61 15.06 (34.08)	151 37.28 (43.64)	82 20.25 (47.95)	63 15.56 (47.37)	405 (41.37)
Total	150 15.32	179 18.28	346 35.34	171 17.47	133 13.59	979 100.00

Table 13. Rear-view camera owners' response to item Q19C by level of 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
Strongly Disagree	8 14.55 (5.37)	6 10.91 (3.37)	20 36.36 (5.80)	11 20.00 (6.43)	10 18.18 (7.58)	55 (5.64)
Disagree	17 12.69 (11.41)	34 25.37 (19.10)	40 29.85 (11.59)	23 17.16 (13.45)	20 14.93 (15.15)	134 (13.74)
Neutral	60 20.55 (40.27)	54 18.49 (30.34)	104 35.62 (30.14)	47 16.10 (27.49)	27 9.25 (20.45)	292 (29.95)
Agree	39 16.53 (26.17)	50 21.19 (28.09)	80 33.90 (23.19)	38 16.10 (22.22)	29 12.29 (21.97)	236 (24.21)
Strongly Agree	25 9.69 (16.78)	34 13.18 (19.10)	101 39.15 (29.28)	52 20.16 (30.41)	46 17.83 (34.85)	258 (26.46)
Total	149 15.28	178 18.26	345 35.38	171 17.54	132 13.54	975 100.00

5. Perceived Effectiveness

Backing aid systems

The perceived operational effectiveness of sensor-based backing aids was evaluated by survey items that asked respondents to judge how well their systems would help them to avoid colliding under several different circumstances (Q13A – Q13F) and weather conditions (Q14A – Q14G). Other questions addressed distance information, timing of alerts, false warnings, failures to warn (Q18G – Q18J) and the perceived range of effectiveness (Q22). The tabulated responses for each of these items are given in Appendix B.

Items Q13A – Q13F asked respondents to rate how well their backing aid system would assist them in avoiding a collision under several different scenarios. Most of these scenarios were written to cover circumstances where the system may not work, including conditions that are often included as warnings in vehicle owner's manual. Item Q13F, which involves backing into a parallel parking space where it is necessary to back very close to the car immediately behind, is the only scenario where the backing aid system should be expected to work perfectly. In fact, 93 percent of respondents reported that their systems work either perfectly or fairly well in this situation.

A large percentage of respondents also thought that their backing aid system would help them to avoid colliding under circumstances where the system probably would work poorly or not at all. Overall, 68 percent of respondents thought that the system would help them avoid colliding with an unseen bicycle if they were backing quickly (10 mph) down a long driveway (Q13B) despite the fact that most backing aid systems do not operate at speeds over 3 to 6 mph. Even for systems which continue to operate at speeds of 10 mph or more, the typically limited detection range of the ultrasonic sensors makes it unlikely that a driver backing quickly would be alerted with enough time to stop before colliding with the unexpected bicycle. An exception may be the extended rear parking assistance system available in Lincoln vehicles. This system provides radar-based detection (up to 20 feet). Among Lincoln owners, 75.3 percent thought that their systems would work fairly well or perfectly for assisting them to avoid colliding in the bicycle scenario. Among non-Lincoln owners, 66.7 percent of respondents thought that their systems would help them avoid colliding in this scenario.

A majority of respondents also thought that their backing aid systems would help them under these other scenarios:

- Backing out of a driveway into the street and into the path of an oncoming car (53%, Q13A)
- Backing out of a garage when there is a child immediately under the rear bumper (53%, Q13C).
- Backing out of a parking space and there is a pedestrian standing 10 feet behind the rear bumper (78%, Q13D). This includes 88 percent of Lincoln owners and 75 percent of all respondents excluding Lincoln owners.
- Backing up to a narrow sign post (87%, Q13E).

The pattern of responses for respondents who are younger than 65 years old differed significantly from that for older respondents for item Q13A, $\chi^2(4) = 9.7$, $p < .05$, and for

item Q13C, $\chi^2(4) = 14.9$, $p < .05$. The results for younger and older respondents to these two items are given in Table 14 and Table 15. Younger respondents were more likely than older respondents to think that the system would be helpful in these situations.

Table 14. Perceived effectiveness of backing aid system for avoiding collision with oncoming vehicles when backing into a street (item Q13A)

Frequency Row Pct. (Col. Pct.)	Younger than 65	65 or Older	Total
Not at all	89 33.97 (23.54)	173 66.03 (26.23)	262 (25.31)
Poorly	49 48.51 (12.96)	52 51.49 (7.91)	101 (9.76)
Fairly Well	114 37.62 (30.16)	189 62.38 (28.77)	303 (29.28)
Perfectly	89 36.48 (23.54)	155 63.52 (23.59)	244 (23.57)
Don't Know	37 29.60 (9.79)	88 70.40 (13.39)	125 (12.08)
Total	378 36.52	657 63.48	1035 100.00

Table 15. Perceived effectiveness of backing aid system for detecting a child immediately under the rear bumper (item Q13C)

Frequency Row Pct. (Col. Pct.)	Younger than 65	65 or Older	Total
Not at all	45 25.42 (11.94)	132 74.58 (20.15)	177 (17.15)
Poorly	24 40.68 (6.37)	35 59.32 (5.34)	59 (5.72)
Fairly Well	72 42.11 (19.10)	99 57.89 (15.11)	171 (16.57)
Perfectly	151 40.16 (40.05)	225 59.84 (34.35)	376 (36.43)
Don't Know	85 34.14 (22.55)	164 65.86 (25.04)	249 (24.13)
Total	377 36.53	655 63.47	1,032 100.00

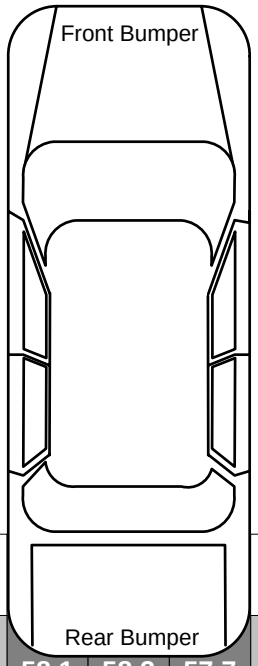
Survey items Q14A – Q14G address how well the backing aid system works in various weather conditions. Nearly all respondents either thought their backing aid system worked well in all of the different weather conditions or they didn't know. For each of the conditions listed, less than 2 percent of respondents thought that their system worked poorly or not at all.

Items Q18G – Q18J asked participants to agree or disagree with each of several statements about their backing aid system regarding distance information, timing of alerts, false warnings, and failure to warn. Overall, respondents seem to be very pleased with the performance of their backing aid systems. They agreed (89%) that their backing aid system gives them a good idea of their distance from an obstacle, and 92 percent agreed that it gives them enough warning time to avoid hitting an obstacle. Only 6 percent think that the backing aid system gives them too many false warnings when they are not in danger of hitting anything, and only 3.8 percent agreed that the backing aid fails to warn them about an obstacle when it should have. The response frequencies for these items are given in Appendix B.

Figure 11 shows the results from item Q22. A total of 907 respondents answered this item by marking some area on the diagram. The number shown in each box indicates the percentage of respondents whose markings included that box. The three different levels of shading shown in the figure were not present on the original questionnaire but have been added here for reference. The darkest shaded region indicates approximately the area where ultrasonic backing aid systems typically are designed to detect obstacles (maximum range of

approximately 5 feet). The medium dark shading indicates the area where some systems may sometimes detect obstacles and the lightly shaded area indicates the approximate extended range claimed by vehicle manufacturers for radar-enhanced backing aids (Lincoln, Jaguar). From these results, it seems that the most respondents have an approximately correct perception about the coverage area of their system. However, there are a small number of respondents who either did not understand the question or have fairly large misconceptions about the coverage area for their backing system. It is interesting to note that even in zones where objects are most likely to be detected (1 to 3 feet directly behind the vehicle) only 72 to 77 percent of respondents marked these areas.

Q22. Suppose that the diagram below shows an overhead view of your vehicle. Based on your experience, write an "X" in all rectangles where you think your backing aid system would detect a small child and give you a warning.



1.0	2.8	12.5			12.7	3.0	1.3
1.4	4.3	42.3	**58.1**	**58.2**	**57.7**	41.5	4.7	1.8
1.8	6.6	45.2	**72.7**	**76.6**	**72.4**	43.8	7.3	1.9
2.0	7.9	31.8	**56.8**			31.1	7.7	2.2
2.0	5.8	17.0	30.4			16.9	6.0	2.0
1.9	4.0	9.6	18.4			9.5	4.3	2.0
1.3	3.1	5.5	10.4			5.4	2.9	1.5
1.0	2.1	3.5	5.7			3.6	2.2	1.2
1.5	2.1	2.6	3.5			2.6	2.1	1.4
1.1	1.3	1.4	1.8			1.4	1.3	1.2
1.0	1.1	1.4	1.7			1.4	1.1	0.9

Distance behind bumper (in feet)

1
3
5
7
9
11
13
15
17
19

Figure 11. Areas where backing aid owners think that their systems would detect a small child (percentage of respondents)

Rear-view cameras

> *"The camera aids greatly in parking, especially parallel parking. It aids in backing up – I saw a second car that way backing up at the same time and avoided problems. And [I] saw a friend behind my car [who] I did not catch with the mirrors." (Male, 56)*

The perceived effectiveness of rear-view camera systems was evaluated by survey items that asked respondents to judge how well their systems function under different weather conditions (Q15A – Q15G). Respondents also were asked to specify the effective field of view for their camera systems (Q18) and they were asked specifically about blind spots (Q19E). Item Q19E and some other items related to the perceived effectiveness of rear-view camera systems are described under the section on, "User Interface and Usability." The tabulated responses for all rear-view camera items are given in Appendix C.

Most respondents either thought their cameras worked well in the various different weather conditions or didn't know. For some conditions, a large percentage didn't know. For example, 75 percent of the respondents didn't know how well their cameras work in snowy conditions. It should be noted that the respondents were all members of the Automobile Club of Southern California where snow is rarely encountered and "cold temperatures" may have a different meaning than if the survey was conducted with residents of Minnesota. The conditions that gave rear-view camera owners the most trouble (i.e., where the system worked poorly or not at all) were in bright sun (10%), darkness (9%), fog (6%), and rain (5%). Ninety respondents wrote about other conditions where their rear-view cameras do not work well. Forty-five people (50%) mentioned some problem related to the vehicle transitioning from light to dark or dark to light. For example, under sunny conditions they had trouble seeing objects in the camera image when backing into or emerging from a dark garage.

> *"The camera seems OK but it's best at night. [During the daytime] it's hard to see the monitor, it's washed out by the sun, and you are wearing sunglasses which makes it hard to see." (Male, 72)*

> *"The screen is washed out in the sun. That needs to be better. And the backup lights need to be brighter at night for the [camera] system to work better." (Female, 44).*

Figure 12 shows the results from item Q18. A total of 953 respondents answered this item by marking some area(s) on the diagram. The number shown in each area indicates the percentage of respondents whose markings included that area.

Q18. Suppose that the diagram below shows an overhead view of your vehicle and areas labeled “A” – “Q”. Based on your experience, please circle the letters for <u>all areas where your rear-view camera would show you obstacles</u> such as a small child sitting on the ground.

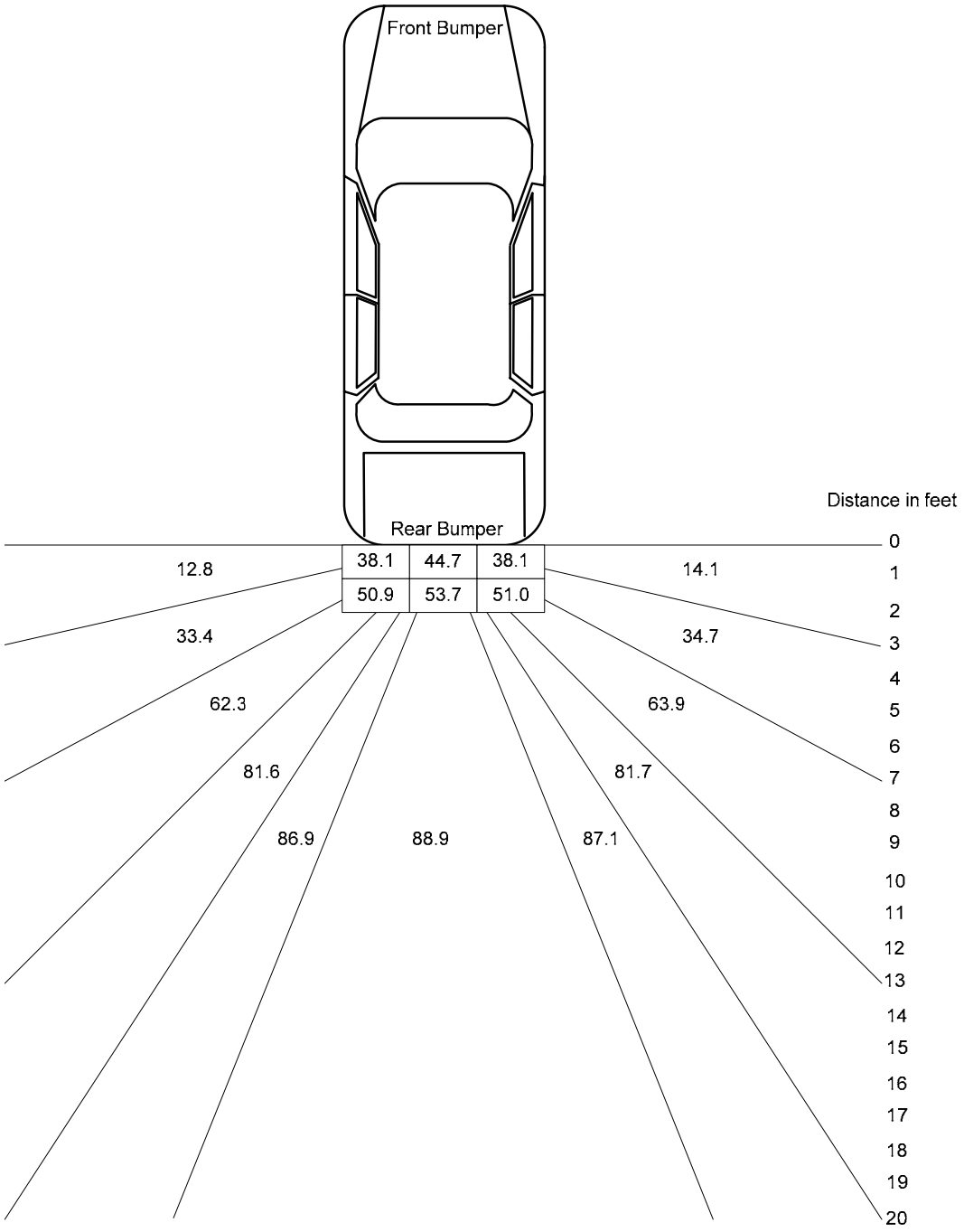


Figure 12. Areas where rear-view camera owners think that their systems would enable them to detect a small child (percentage of respondents)

6. User Interface and Usability

Backing aid system

> *" . . . [backing aid] system uses the same bell as the seat belt. It would be nice for another tone; it also needs to be louder! If 3 or 4 people are in the car, or the radio is on, it is hard to hear it." – (Male, 75)*
>
> *"It would help if it beeped when you first put the transmission in reverse to let you know the system is active, and that you are in a car with this type of device." – (Male, 43)*

The user interface and usability for backing aid systems was evaluated by survey items Q15 (reliance on auditory versus visual indications), Q18A (system sounds), and Q18B (system visual display). The tabulated responses for each of these items are given in Appendix B.

Respondents who answered item Q15 as if they have both visual and auditory indicators on their backing aid system tended to rely more on the sounds (65.2%) or to rely on the lights/symbols and sounds about equally (31.4%). Few respondents who have both auditory and visual displays said that they rely more on the visual display (3.4%). These responses do not depend significantly on the respondent's age group, $\chi^2(2) = 3.3$, $p = .19$.

The auditory and visual aspects of the user interface were also considered in items Q18A and Q18B. A higher percentage of younger drivers (78.3%) as compared to older drivers (67%) strongly agree with the statement that "it's easy to hear the sounds made by the backing aid system." Older drivers (29.9%) were more likely to simply agree with the statement than were younger drivers (17.7%). Less than 2 percent of older and younger respondents disagreed or strongly disagreed with the statement.

For item 18B, respondents were asked to agree or disagree with the statement that "it's easy to see the lights/symbols on the backing aid system." Apparently, many respondents (56.6%) do not have lights/symbols on their backing aids because they selected "NA" (not applicable) for this item. Of the remaining 423 respondents who presumably have a visual indicator on their systems, 72.3 percent either agreed or strongly agreed with the statement, 9.9 percent disagreed or strongly disagreed, and 17.7 percent were neutral. When the "NA" responses were eliminated, the distribution of responses on item 18B for younger respondents did not differ significantly from that for older respondents, $\chi^2(4) = 5.3$, $p = .26$.

Rear-view camera

Issues related to the user interface and usability of the rear-view camera system were evaluated by survey items Q14 (visual overlays), Q16 (ease of use), Q19A (location of display), and Q19D – Q19I (distance judgments, blind spots, image quality while moving, dirt on camera, sun glare on video display, image contrast). Tabulated responses for each of these items are given in Appendix C.

Certain vehicles manufactured by Infiniti have a system of lines and other markings that are displayed on the rear-view camera monitor. These are designed to help the driver estimate distance to objects and predict heading of the vehicle as it backs up. Item Q14 asked respondents who have such lines and markings whether they find them useful. As expected most respondents (83%) said that they do not have this feature (including 34% of Infiniti owners). Of the 176 remaining respondents who responded either "Yes" or "No" to this item

as if they have the feature, 76 were Infiniti owners. Among this group of Infiniti owners, 75 (98.7%) responded "Yes," that they found this feature useful.

> *"The distance graphics on my screen seem well thought out and they are accurate. I got used to it right away." – (Male, 56)*

Various comparisons were made between the three manufacturers with large enough samples to be statically valid (Acura, Infiniti, and Lexus). Each of the Acura owners with a camera in this survey owned an MDX; the highest percentage of Infiniti models were the FX (42.7%), and the highest percentage of the Lexus models were the RX (57.7%). The complete breakdown of vehicle models can be found in Appendix C.

Respondents were asked (Q16) to rate how easy it is to use the rear-view camera when backing out of a driveway. Most (95.9%) indicated that it was either very easy or somewhat easy to use and only 3 percent indicated that it was somewhat or very difficult to use. A significantly higher percentage of younger respondents (81.1%) selected the "Very Easy" response as compared to older respondents (70.7%), $z = 3.08$, $p < .01$.

Among Acura, Infiniti, and Lexus owners, Infiniti owners had the highest percentage of respondents (88.8%) who indicated that the system was very easy to use as compared to 84.4 percent of Acura owners and 74.5 percent of Lexus owners. The difference between Acura and Infiniti is not statistically significant, $z = 1.20$, $p = .23$, however, the difference between Acura and Lexus is statistically significant, $z = 3.52$, $p < .001$, as is the difference between Infiniti and Lexus, $z = 4.20$, $p < .001$.

The location of the camera screen is satisfactory for most owners (Q19A). Only 2 percent of respondents disagreed or strongly disagreed with the statement that "the rear-view camera screen is in a location where it is easy to see when I am backing." The distribution of responses to this item differed significantly for younger camera owners as compared to older camera owners $\chi^2(4) = 19.8$, $p < .001$. As shown in Table 16, the younger camera owners were more likely than older camera owners to strongly agree with the statement. Approximately 62 percent of Infiniti owners, 52 percent of Acura owners, and 48 percent of Lexus owners strongly agreed with the statement.

Table 16. Rear-view camera screen is in a location where it is easy to see when I am backing: Item Q19A by age group.

Frequency Row Pct. (Col. Pct.)	Younger than 65	65 or Older	Total
Strongly Disagree	6 66.67 (0.73)	3 33.33 (1.43)	9 (0.87)
Disagree	9 75.00 (1.09)	3 25.00 (1.43)	12 (1.16)
Neutral	37 72.55 (4.50)	14 27.45 (6.67)	51 (4.94)
Agree	321 74.31 (39.05)	111 25.69 (52.86)	432 (41.86)
Strongly Agree	449 85.04 (54.62)	79 14.96 (37.62)	528 (51.16)
Total	822 79.65	210 20.35	1,032 100.00

The responses for item Q19D ("It's easy to tell how close I am to an obstacle by looking at the rear-view camera display") depended significantly on the respondent's age group, $\chi^2(4) = 20.3$, $p < .001$, and on the respondent's vehicle manufacturer, $\chi^2(8) = 51.2$, $p < .0001$. Younger respondents and Infiniti owners tended to agree more strongly with the statement. The additional graphical overlay elements on the Infiniti shown rear-view camera monitor may help drivers to more easily judge distances to objects seen in the camera view. The results from item Q19D are shown in Table 17 by age group and in Table 18 by vehicle manufacturer.

Table 17. It's easy to tell how close I am to an obstacle by looking at the rear-view camera display: Item Q19D by age group.

Frequency Row Pct. (Col. Pct.)	Younger than 65	65 or Older	Total
Strongly Disagree	26 70.27 (3.17)	11 29.73 (5.24)	37 (3.59)
Disagree	105 72.92 (12.79)	39 27.08 (18.57)	144 (13.97)
Neutral	152 73.08 (18.51)	56 26.92 (26.67)	208 (20.17)
Agree	293 81.84 (35.69)	65 18.16 (30.95)	358 (34.72)
Strongly Agree	245 86.27 (29.84)	39 13.73 (18.57)	284 (27.55)
Total	821 79.63	210 20.37	1,031 100.00

Table 18. It's easy to tell how close I am to an obstacle by looking at the rear-view camera display: Item Q19D by vehicle manufacturer

Frequency Row Pct. (Col. Pct.)	Acura	Infiniti	Lexus	Total
Strongly Disagree	6 16.22 (2.26)	0 0.00 (0.00)	31 83.78 (4.99)	37 (3.70)
Disagree	34 24.29 (12.83)	7 5.00 (6.19)	99 70.71 (15.94)	140 (14.01)
Neutral	59 29.50 (22.26)	10 5.00 (8.85)	131 65.50 (21.10)	200 (20.02)
Agree	90 26.09 (33.96)	38 11.01 (33.63)	217 62.90 (34.94)	345 (34.53)
Strongly Agree	76 27.44 (28.68)	58 20.94 (51.33)	143 51.62 (23.03)	277 (27.73)
Total	265 26.53	113 11.31	621 62.16	999 100.00

Item Q19E asked respondents about the coverage of their camera systems' field of view. Specifically, they were asked whether they agree or disagree with the statement that "the rear-view camera does not show the entire area behind the vehicle that I need to see when backing, in other words there is a blind spot." Approximately 36 percent of respondents agree or strongly agree with this statement, 26 percent are neutral, and 38 percent disagree or strongly disagree. The overall distribution of responses did not depend significantly on vehicle manufacturer, $\chi^2(8) = 9.6$, $p = .29$, nor did it depend significantly on age group, $\chi^2(4) = 2.0$, $p = .74$.

Responses to item Q19F also did not depend significantly on the respondent's age group, $\chi^2(4) = 7.3$, $p = .12$. Although most respondents (85%) either disagree or strongly disagree with the statement "the rear-view camera display gets blurry or hard to see if I am moving," the percentage who strongly disagree was significantly higher for Infiniti owners (44%) than for Lexus owners (30%), $z = 2.83$, $p < .01$.

Item Q19G asked about the problem of dirt on the rear-view camera. Overall, approximately five percent of camera owners agreed that this was a problem. The response frequencies for Acura, Infiniti, and Lexus vehicle owners are shown in Table 19. Statistically significant differences were observed between vehicle manufacturers, $\chi^2(8) = 16.6$, $p < .05$.

Table 19. The rear-view camera gets dirty and makes obstacles hard to see: Item Q19G by vehicle manufacturer

Frequency Row Pct. (Col. Pct.)	Acura	Infiniti	Lexus	Total
Strongly Disagree	86 30.60 (32.33)	43 15.30 (37.72)	152 54.09 (24.60)	281 (28.16)
Disagree	138 27.01 (51.88)	48 9.39 (42.11)	325 63.60 (52.59)	511 (51.20)
Neutral	28 19.18 (10.53)	16 10.96 (14.04)	102 69.86 (16.50)	146 (14.63)
Agree	12 26.09 (4.51)	6 13.04 (5.26)	28 60.87 (4.53)	46 (4.61)
Strongly Agree	2 14.29 (0.75)	1 7.14 (0.88)	11 78.57 (1.78)	14 (1.40)
Total	266 26.65	114 11.42	618 61.92	998 100.00

As compared to the percentage of respondents those who think that the camera getting dirty is a problem, many more respondents recognized sun glare on the video display as a problem. For item Q19H, 27 percent of respondents either agree or strongly agree with the statement that "sun glare on the video display makes it hard for me to see objects or people." The responses depended significantly on age group, $\chi^2(4) = 20.3$, $p < .001$, with older respondents being more likely than younger respondents to report a problem with glare. The results for younger and older respondents are shown in Table 20. The results also depend significantly on vehicle manufacturer, $\chi^2(8) = 26.8$, $p < .001$. Among the three vehicle manufacturers compared, Acura owners were most likely to report glare as a problem, and Infiniti owners were least likely (see Table 21).

Table 20. Sun glare on the video display makes it hard for me to see objects or people: Item Q19H by age group

Frequency Row Pct. (Col. Pct.)	Younger than 65	65 or Older	Total
Strongly Disagree	143 83.63 (17.57)	28 16.37 (13.73)	171 (16.80)
Disagree	320 85.33 (39.31)	55 14.67 (26.96)	375 (36.84)
Neutral	154 77.00 (18.92)	46 23.00 (22.55)	200 (19.65)
Agree	151 77.04 (18.55)	45 22.96 (22.06)	196 (19.25)
Strongly Agree	46 60.53 (5.65)	30 39.47 (14.71)	76 (7.47)
Total	814 79.96	204 20.04	1,018 100.00

Table 21. Sun glare on the video display makes it hard for me to see objects or people: Item Q19H by vehicle manufacturer.

Frequency Row Pct. (Col. Pct.)	Acura	Infiniti	Lexus	Total
Strongly Disagree	41 25.15 (15.59)	29 17.79 (25.66)	93 57.06 (15.22)	163 (16.51)
Disagree	76 20.94 (28.90)	46 12.67 (40.71)	241 66.39 (39.44)	363 (36.78)
Neutral	50 26.18 (19.01)	19 9.95 (16.81)	122 63.87 (19.97)	191 (19.35)
Agree	68 35.05 (25.86)	13 6.70 (11.50)	113 58.25 (18.49)	194 (19.66)
Strongly Agree	28 36.84 (10.65)	6 7.89 (5.31)	42 55.26 (6.87)	76 (7.70)
Total	263 26.65	113 11.45	611 61.90	987 100.00

The subjective quality of image contrast provided by rear-view camera systems was assessed with item Q19I. Approximately 9.5 percent of respondents agree or strongly agree with the statement that "it's hard to distinguish something or someone who may be in a shadow area behind my vehicle (image contrast is poor in camera)." The responses to this item depended significantly on age group, $\chi^2(4) = 30.9$, $p < .0001$. Younger camera owners tended to disagree or strongly disagree with this statement more often than older camera owners (see Table 22). The responses to this item were also significantly related to the respondent's vehicle manufacturer, $\chi^2(8) = 21.2$, $p < .01$. These results are shown in Table 23. Infiniti owners tended to be less neutral and tended to disagree or strongly disagree with the statement more often than Acura and Lexus owners.

Table 22. It's hard to distinguish something or someone who may be in a shadow area behind my vehicle (image contrast is poor in camera): Item Q19I by age group.

Frequency Row Pct. (Col. Pct.)	Younger than 65	65 or Older	Total
Strongly Disagree	199 88.44 (24.51)	26 11.56 (12.94)	225 (22.21)
Disagree	364 82.92 (44.83)	75 17.08 (37.31)	439 (43.34)
Neutral	184 72.73 (22.66)	69 27.27 (34.33)	253 (24.98)
Agree	52 65.82 (6.40)	27 34.18 (13.43)	79 (7.80)
Strongly Agree	13 76.47 (1.60)	4 23.53 (1.99)	17 (1.68)
Total	812 80.16	201 19.84	1,013 100.00

Table 23. It's hard to distinguish something or someone who may be in a shadow area behind my vehicle (image contrast is poor in camera): Item Q19I by vehicle manufacturer.

Frequency Row Pct. (Col. Pct.)	Acura	Infiniti	Lexus	Total
Strongly Disagree	63 28.90 (24.32)	37 16.97 (32.74)	118 54.13 (19.34)	218 (22.20)
Disagree	108 25.59 (41.70)	54 12.80 (47.79)	260 61.61 (42.62)	422 (42.97)
Neutral	64 25.91 (24.71)	14 5.67 (12.39)	169 68.42 (27.70)	247 (25.15)
Agree	18 23.08 (6.95)	8 10.26 (7.08)	52 66.67 (8.52)	78 (7.94)
Strongly Agree	6 35.29 (2.32)	0 0.00 (0.00)	11 64.71 (1.80)	17 (1.73)
Total	259 26.37	113 11.51	610 62.12	982 100.00

7. Safety

Perceived safety of backing aid systems and rear-view cameras

> *"I feel safer with the [rear-view camera] system. It has helped me see kids behind my car in parking lots when the parents were not paying attention to them." – (Male, 70)*

On both the backing aid questionnaire and the rear-view camera questionnaire owners were asked, "Overall, does having the (backing aid / rear-view camera) make you a safer driver?" The responses are shown in Figure 13. The majority of respondents (close to 80%) thought that these systems did make them safer drivers, and less than 1 percent felt that having the systems made them less safe. Another closely related item asked, "Does using the (backing aid / rear-view camera) create any new driving problems or safety concerns for you?" The responses to this item are shown in Figure 14. While the vast majority of respondents did not have any concerns, approximately three percent of backing aid owners and seven percent of rear-view camera owners indicated that they did have some safety concerns. A follow-up item asked respondents to explain their safety concerns. The resulting text strings were read by data coding staff and categorized according to meaning. The most commonly mentioned concern for both systems was "becoming too dependent on the device."

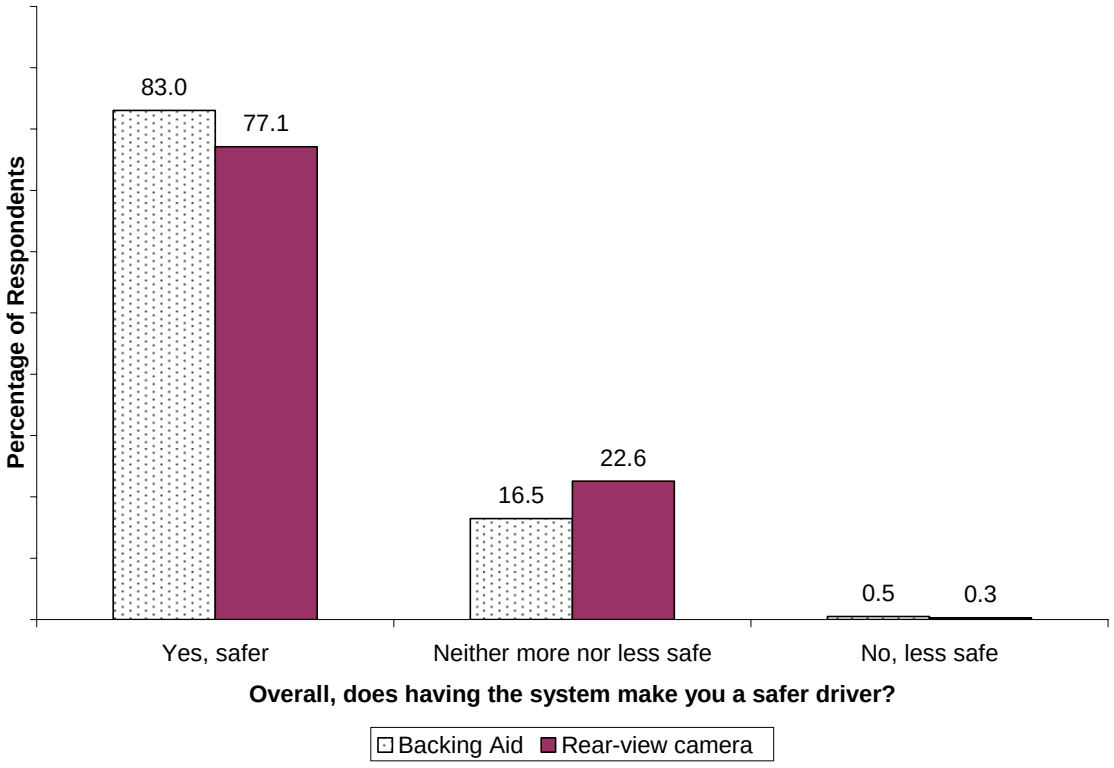


Figure 13. Perceived safety benefits of backing aid systems and rear-view cameras

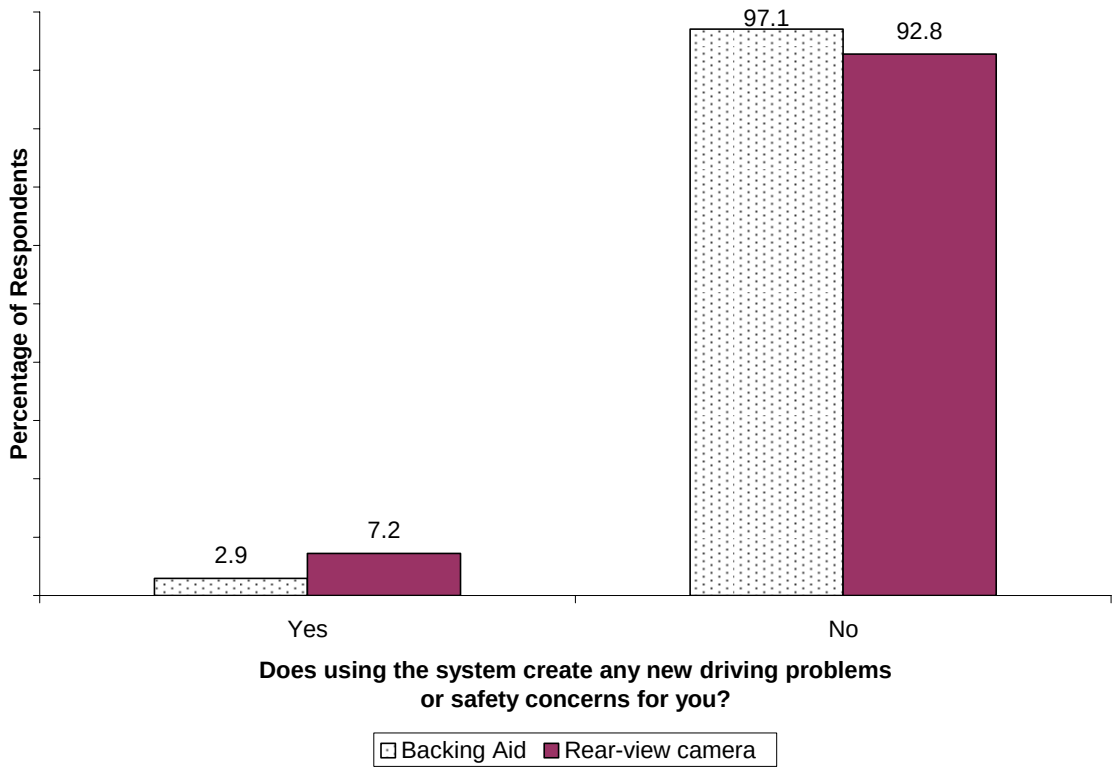


Figure 14. Safety concerns about backing aid systems and rear-view cameras

Awareness of system limitations

Although vehicle owner's manuals typically list warnings and limitations regarding the backing aid system and rear-view camera, a minority of respondents were aware of "any warnings or limitations" about their vehicles' backing aid systems (21%) or rear-view cameras (39%) (item Q8). Table 24 shows the eight most common vehicle makes represented by respondents to the backing aid survey. The percentage of respondents who were aware of system limitations varies by manufacturer from 14 percent of Jaguar owners to nearly 30 percent of Ford owners. These differences are statistically significant, $\chi^2(7) = 16.18$, $p < .05$. Differences in responses to this item (Q8) on the rear-view camera survey between Acura, Infiniti, and Lexus owners also were statistically significant, $\chi^2(2) = 9.02$, $p < .05$. Approximately 32 percent of Acura owners, 43 percent of Infiniti owners, and 42 percent of Lexus owners said that they were aware of warnings or limitations about their rear-view camera.

Table 24. Awareness of backing aid system limitations by vehicle manufacturer

Frequency Row Pct. (Col. Pct.)	BMW	Buick	Cadillac	Ford	Jaguar	Lincoln	Nissan	Toyota	Total
Yes	8 4.57 (20.51)	9 5.14 (18.00)	36 20.57 (15.25)	38 21.71 (29.69)	27 15.43 (14.21)	37 21.14 (19.79)	9 5.14 (27.27)	11 6.29 (21.15)	175 (19.13)
No	31 4.19 (79.49)	41 5.54 (82.00)	200 27.03 (84.75)	90 12.16 (70.31)	163 22.03 (85.79)	150 20.27 (80.21)	24 3.24 (72.73)	41 5.54 (78.85)	740 (80.87)
Total	39 4.26	50 5.46	236 25.79	128 13.99	190 20.77	187 20.44	33 3.61	52 5.68	915 100.00

For owners of backing aid systems, awareness of warnings or limitations of the system was significantly related to age $\chi^2(1) = 9.9$, $p < .01$. A higher percentage of younger respondents (25.7%) were aware of system limitations as compared to those respondents who are 65 years or older (17.5%). Among rear-view camera owners, the difference between the percentage of younger (38.2%) and older (44.4%) respondents who were aware of warnings or limitations about their camera system failed to reach statistical significance $\chi^2(1) = 2.8$, $p = .10$.

When asked how well their backing aid system would assist them to avoid colliding under specific circumstances, ratings from respondents who said that they were not aware of warnings or limitations about their backing aid system (Q8) differed significantly from ratings from those who said that they were aware of system limitations. Respondents who were not aware of system limitations generally were more likely to say that their system would help them to avoid colliding under the following scenarios:

- Q13B: "You are backing quickly down a long driveway, going about 10 mph. There is a bicycle behind the vehicle that you didn't see," $\chi^2(4) = 17.8$, $p < .01$.
- Q13C: "You begin to back out of a garage and there is a child immediately under the rear bumper," $\chi^2(4) = 14.7$, $p < .01$.
- Q13E: "You are backing up to a narrow sign post," $\chi^2(4) = 22.1$, $p < .01$.
- Q14F: "You are backing into a parallel parking space. The space is tight and you have to back very close to the car behind you," $\chi^2(4) = 14.7$, $p < .01$.

Experience with backing collisions and near collisions

Approximately 14 percent of both rear-view camera owners (Q20) and backing aid system owners (Q16) reported having backed into something or had a "close call" since they started driving their current (equipped) vehicles. In descriptions of the incidents, the most frequently mentioned scenario involved colliding or nearly colliding with a stationary object. Pedestrians (persons) were mentioned by 4.8 percent of the rear-view camera owners (n = 7) reporting incidents and by 12.2 percent of backing aid owners (n =18) reporting incidents.

The percentage of backing aid owners who said that they had experienced a backing collision or "close call" while driving their own vehicles (Q16) was significantly higher among respondents who reported that they had learned how to use their systems (Q7) only through

on-road experience (18.8%) as compared to those who reported that they had learned to use their system from other methods or from multiple methods including on-road experience (12.8%) $\chi^2(1) = 5.9$, $p < .05$. Respondents who said that they were aware of warnings or limitations about their backing aid system (Q8) were nearly twice as likely to report having experienced a backing collision or "close call" (23%) as compared to those who said that they were not aware of any system limitations (12.2%) $\chi^2(1) = 15.3$, $p < .001$. Perhaps experiencing a "close call" or backing collision makes some owners aware of the limitations of their systems.

Nearly 18 percent of backing aid system owners reported that since obtaining their vehicles they had experienced a backing collision or "close call" while they were driving another vehicle that was not equipped with a backing aid system because they expected the other vehicle to give them a warning (Q17). Younger respondents (23%) reported having experienced this problem significantly more frequently than did those who were 65 years or older (14.6%), $\chi^2(1) = 11.5$, $p < .001$.

Reaction to unexpected warnings

Among backing aid respondents, 68.6 percent reported that they had experienced an unexpected warning when backing because they didn't know what was behind the vehicle (Q20). For those who had experienced this, approximately 18 percent said that the reason for the warning was a person (pedestrian) and approximately 18 percent said that it was another vehicle. Nearly 26 percent said that it was due to a pole, post, or tree. Those who had experienced an unexpected warning were asked how they reacted the last time this happened. The majority (63.8%) stopped immediately and checked their mirrors and/or looked out the rear window before continuing to back up. Less than one percent of respondents said that they had ignored the warning because they were sure that there wasn't any obstacle behind them. Nearly one third of respondents got out of their vehicles and checked for obstacles. Younger respondents (38.5%) were more likely to get out of their vehicles and check for obstacles than were respondents who were 65 or older (29.4%). This difference is statistically significant, $z = 2.44$, $p < .05$.

8. Need for Improvements to Backing Aid System and Rear-View Camera

> *"I would like the [rear-view] camera to rotate left and right for a better idea of what's behind me and I would like greater depth perception in the image. I would also like a distance gauge." (Female, 55)*
>
> *"I would like to see wider coverage from the camera, perhaps use two cameras so you can see more to each side of the vehicle. Also you need to be able to see very low and just behind the bumper, my camera doesn't show that now." (Male, 43)*
>
> *"I would like a 'lower view,' 'left view,' and 'right view,' like a picture in picture on the screen. (Female, 36)*
>
> *"The camera needs to show more of what's going on the left and right. The screen needs to have more contrast and a sun shade to prevent washout. They need better depth of view or depth perception to the*

screen, perhaps two video cameras to provide depth of vision." (Male, 63)

Respondents were asked whether there is anything about the way that their backing aid systems (Q24) or rear-view cameras (Q23) work that should be improved. A much higher percentage of rear-view camera owners (46%) than backing aid owners (24%) reported a need for improvements. The two most frequently cited areas suggested for improvement for the rear-view camera were to increase the coverage of the camera view (mentioned by nearly 25 percent of respondents to this item) and to improve the quality of the picture shown on the rear-view monitor (23%). Other common suggestions were related to adding audio features to the camera system to indicate the distance or presence of objects (10%), and improving the ability to judge distance to objects seen on the monitor (17%). For backing aid systems the suggestions given for improvement were more difficult to categorize. The most common responses involved improving the range of sensors to the sides of the vehicle (13.5%), adding more audio features (12.7%), adding sensors on the front of the vehicle (8.4%), and adding video-based features, or camera views (6.8%).

During the follow-up telephone interviews with backing aid system owners, several respondents commented on poor sensitivity of backing aids for detecting low objects and objects to the side of (i.e., not directly behind) their vehicles.

"Sensitivity is bad for a low object. A railing off to the side is not easily detected either." (Male, 81)

"It would help if it beeped when you first put the transmission in reverse to let you know the system is active, and that you are in a car with this type of device." (Male, 43)

"[Backing aid] can't detect the sides or perhaps a vehicle behind you who is also backing up quickly . . . sensors should be spaced out further apart, and 5 – 6 degrees directed outwardly; this would help." (Male, 84)

9. Meeting the Needs of Older Drivers

Respondents on both the backing aid survey and the rear-view camera survey were asked whether they "believe that car manufacturers are doing enough to design vehicles to accommodate an aging population." Most of those responding to the backing aid survey (73.6%) said "Yes" to this question, as did most of the respondents to the rear-view camera survey (75.2%).

No significant differences in the responses to this item were noted between Acura, Infiniti, and Lexus owners on the rear-view camera survey, however, among respondents to the backing aid survey there were significant differences in responses based on the respondents' vehicle manufacturer $\chi^2(7) = 19.2$, $p < .01$. These results are shown in Table 25. The percentage of those responding "Yes" to item Q25 varies from 67 percent for Buick owners to 87 percent for Ford owners.

Table 25. Response to item Q25 (backing aid survey) by vehicle manufacturer: “In general, do you believe that car manufacturers are doing enough to design vehicles to accommodate an aging population?”

Frequency Row Pct. (Col. Pct.)	BMW	Buick	Cadillac	Ford	Jaguar	Lincoln	Nissan	Toyota	Total
Yes	28 4.33 (68.29)	31 4.79 (67.39)	183 28.28 (78.21)	103 15.92 (87.29)	117 18.08 (68.02)	129 19.94 (70.88)	22 3.40 (73.33)	34 5.26 (77.27)	647 (74.63)
No	13 5.91 (31.71)	15 6.82 (32.61)	51 23.18 (21.79)	15 6.82 (12.71)	55 25.00 (31.98)	53 24.09 (29.12)	8 3.64 (26.67)	10 4.55 (22.73)	220 (25.37)
Total	41 4.73	46 5.31	234 26.99	118 13.61	172 19.84	182 20.99	30 3.46	44 5.07	867 100.00

Data from both the backing aid survey and rear-view camera survey were combined and the responses to this question were compared between age groups. Among those who were younger than 65 years old, 77.6 percent responded affirmatively to this question as compared to 73.2 percent of those who were 65 years or older. This difference is statistically significant, $z = 2.19$, $p < .05$.

SUMMARY AND DISCUSSION

Summary of Findings

Questionnaires were mailed to vehicle owners who were possibly owners of sensor-based backing aids and rear-view cameras in an effort to understand how these types of systems are influencing driver behavior (modifying behavior in potentially positive or negative ways) and to assess the extent to which early adopters of these systems understand the systems' performance capabilities and limitations. The majority of both rear-view camera owners and backing aid owners think that their systems make them safer drivers and most said that they would want to get the systems if they purchased the same vehicles again, but many system owners were unaware of the limitations of their systems. They also tend to overestimate their systems' effectiveness, and they tend to rely more on the systems as they gain more experience driving their vehicles.

Survey samples

Approximately 30 percent of the backing aid questionnaires and rear-view camera questionnaires were returned from a mail-out survey to 10,000 ACSC insurance customers who were identified as owning vehicle models likely to have one of these technologies. 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. Of the questionnaires returned, 1,087 were from backing aid owners and 1,069 were from rear-view camera owners. The samples of system owners differed in several respects:

- Respondents with backing aid systems tended to be older (median age = 69) than respondents with rear-view cameras (median age = 51).
- More of the respondents with rear-view cameras were women (47%) as compared to those with backing aid systems (38%).
- Fewer vehicle manufacturers were represented among the sample of rear-view camera owners than among the sample backing aid owners.
- On average, backing aid owners had more experience driving their vehicles (median = 15,000 miles) than did rear-view camera owners (median = 12,000 miles).

Desire to have backing assistance technologies

An overwhelming majority of those who currently have either backing aid systems (98%) or rear-view cameras (93%) said that if they purchased their same vehicles again, they would want to get the technology again. Among those who do not currently have the technology, the most common reasons cited for not purchasing it were related to availability on the specific vehicle that they purchased or lack of knowledge about the systems. Cost was cited as a reason by 9 percent of those who did not purchase backing aid systems and by 21 percent of those who did not purchase rear-view cameras.

Learning to use the technology

Similar patterns of results were obtained on the backing aid survey and the rear-view camera survey for the methods that owners used to learn how to operate their systems. The most

frequently reported methods were “on-road experience and practice (trial and error)” and “instructions from the dealership . . .” Among backing aid owners, the proportions of respondents who cited these learning methods varied significantly by vehicle manufacturer.

Behavioral adaptation

The percentage of rear-view camera owners who said that they use their systems more now than when they first obtained their vehicles was not significantly related to their level of experience with the vehicle. However, backing aid owners seem to rely more on their systems as their experience with their vehicles increases. Owners of either type of system generally are more confident about their backing abilities using the system and it may be concluded from the results that many of them tend to back up faster and to park in tighter parking spaces than they would if they didn’t have the system. With the systems in their vehicles some owners rely less on checking mirrors and making direct glances over their shoulders.

- If their systems stopped functioning, approximately a third of backing aid and camera owners said that their driving behavior would not change. However, approximately 61 percent of both backing aid owners and rear-view camera owners said that they would rely more on their mirrors and/or glances over their shoulders. A higher percentage of backing aid owners (40%) than rear-view camera owners (27%) said that they would back up much more slowly. The proportion of backing aid owners who said that they would avoid parking in tight spaces and the proportion who would back up much more slowly tended to increase with experience.
- Approximately 17 percent of rear-view camera owners and 12 percent of backing aid owners admitted backing without checking their mirrors or turning to look out the rear window within the last two weeks. Younger rear-view camera owners were more likely have done this than were older camera owners.
- Approximately 67 percent of rear-view camera owners said that they normally share their attention equally between the rear-view camera screen, mirrors, and direct glances out the rear window, and 22 percent said that they usually just take a quick glance at the camera screen to determine if they can back up. Seven percent pay more attention to the camera screen than to mirrors or direct glances out the windows. Younger respondents were more than twice as likely as older respondents to do this.
- Approximately 70 percent of respondents agreed that they are more confident in their ability to detect pedestrians when they use the backing aid systems.
- Several items that asked owners to agree versus disagree with specific statements about their use of the technology indicate increased reliance with higher levels of experience.
- Nearly 18 percent of backing aid system owners reported that since getting their vehicles they had experienced a backing collision or “close call” while they were driving another vehicle without a backing aid system because they expected to receive a warning.

Perceived effectiveness

Backing aid owners were generally satisfied with the performance of their backing aid systems under several different weather conditions, although for some conditions such as snow, a large percentage of respondents didn't know how well their systems would work. A topic of greater concern than performance in weather is that a large percentage of respondents thought that their backing aid systems would help them to avoid a collision under several scenarios where the technology would likely not be effective. In fact, a majority of respondents thought that their systems would be effective when:

- Backing quickly (10 mph)
- Backing out of a driveway into the street and into the path of an oncoming car
- Backing out of a garage when there is a child immediately under the rear bumper
- Backing out of a parking space and there is a pedestrian standing 10 feet behind the rear bumper
- Backing up to a narrow sign post

Younger respondents were more likely than older respondents to think that their systems would be helpful in detecting a child immediately under the rear bumper and in avoiding a collision with oncoming vehicles when backing into a street. Overall, respondents seem to be very pleased with (or confident about) the performance of their backing aid systems. They agreed that their backing aid systems:

- Give them a good idea of their distance from an obstacle (89%)
- Give them enough warning time to avoid hitting an obstacle (92%)

Only 6 percent thought that the backing aid system gives them too many false warnings when they are not in danger of hitting anything, and only 3.8 percent agreed that the backing aid fails to warn them about an obstacle when it should have.

Among owners of rear-view cameras, most thought that their cameras worked fairly well or perfectly in various weather conditions, or didn't know. The conditions that gave the most people trouble were:

- Bright sun (10%)
- Darkness (9%)
- Fog (6%)
- Rain (5%)
- Several dozen respondents (n = 45) mentioned difficulties with the camera system when backing from either light to dark areas or from dark to light areas.

User interface and usability

There were only a few questions on the survey which addressed the user interface of backing aids. Most backing aid owners in the survey rely on auditory indications from their systems, although many may not have (or be aware of) any visual indicators as part of the user

interface to their systems. Younger drivers were more likely than older drivers to strongly agree that the sounds made by the system were easy to hear.

For rear-view camera systems –

- Most respondents (96%) found their cameras to be easy or very easy to use when backing out of a driveway.
- Approximately 36 percent of respondents agreed or strongly agreed with the statement that "the rear-view camera does not show the entire area behind my vehicle that I need to see when backing, in other words there is a blind spot."
- Five percent of respondents agreed that dirt on the rear-view camera caused a problem for seeing obstacles.
- Most respondents did not agree with the statement that "it's hard to distinguish something or someone who may be in a shadow area behind my vehicle (image contrast is poor in camera)." However, older camera owners were less likely than younger camera owners to disagree or strongly disagree, possibly indicating that older system owners may have more trouble seeing objects in the video image.
- Infiniti owners were singled out for analysis regarding the video overlay system of lines and markings on their systems which help the driver to judge distance and predict backing direction. Nearly every Infiniti owner who has this system found it useful. Responses to several other items on the questionnaire differed by vehicle manufacturer and Infiniti owners generally rated their systems more highly than did Acura owners or Lexus owners.
- Infiniti owners, and owners who were younger than 65 years old tended to agree more strongly with the statement that "it's easy to tell how close I am to an obstacle by looking at the rear-view camera."
- Sun glare on the video display was a problem for 27 percent of respondents, and older respondents were more likely than younger respondents to agree that this was a problem. Among the three vehicle manufacturers compared, Acura owners were most likely to agree that sun glare is a problem.
- The location of the screen (video monitor) seems to be satisfactory for most camera owners. Only 2 percent disagreed or strongly disagreed that it is in a location where it is easy to see when backing. Higher proportions of younger respondents and Infiniti owners tended to strongly agree that the screen location was easy to see.

<u>Safety</u>

- The majority of both backing aid owners and rear-view camera owners thought that having their systems made them safer drivers. Less than one percent thought that it made them less safe.
- Seven percent of rear-view camera owners and three percent of backing aid owners said that their systems create some safety concerns for them. The most commonly mentioned concern was becoming too dependent on their systems.

- Only 21 percent of backing aid owners and 39 percent of rear-view camera owners reported that they were aware of "any warnings or limitations" about their system. The percentage of respondents who said that they were aware of warnings or limitations varied significantly by vehicle manufacturer. Also, a higher percentage of younger backing aid owners (26%) as compared to older owners (18%) were aware of system limitations.
- Since obtaining their vehicles, 14 percent of both rear-view camera owners and backing aid owners reported having backed into something or had a "close call." The last time this happened, only a third of the respondents said that they got out of their vehicles to check for obstacles. Younger respondents were more likely to have gotten out of their vehicles to check for obstacles than were older respondents.

Need for improvements

The two most frequently cited areas suggested for improvement for rear-view cameras were to increase the coverage of the camera view and to improve the quality of the picture shown on the rear-view monitor. For backing aid systems the most common suggestions involved improving the range of sensors to the sides of the vehicle and adding more audio features.

Approximately 75 percent of survey respondents thought that vehicle manufacturers are doing enough to design vehicles to accommodate an aging population. This percentage varied significantly by vehicle manufacturer for the backing aid survey but did not vary significantly by manufacturer for the rear-view camera survey. Younger respondents were more likely than older respondents to say that vehicle manufacturers were doing enough.

Summary of comparisons by age group

Responses from system owners who were 65 years old or more were compared to those from system owners who were younger than 65 years. The statistically significant differences between these groups are numerous.

For the backing aid survey, older respondents:

- Reported more hearing problems and "more difficulty turning my head/neck." (A higher percentage of younger respondents reported that they have no physical conditions that make driving more difficult.)
- Were more likely to say that they would want to get the system again.
- Had less experience driving their vehicles as compared to younger respondents.
- Were more likely than younger respondents to have learned how to operate their systems from the owner's manual. (A higher percentage of younger respondents learned to use their systems from on-road experience and practice.)
- Were less likely to be aware of warnings and limitations about their systems.
- Were more likely to say that they would "rely more on mirrors and/or glances over my shoulder" if their backing aid systems broke down. (A higher percentage of younger respondents would "not try to fit into tight parking spaces.")

- Had a different distribution of responses for items Q13A, Q13C, and Q13F than did younger backing aid owners. These items asked system owners to rate how well their backing aid systems would assist them to avoid colliding under different circumstances. The specific circumstances where ratings from older and younger system owners differed were: Q13A – slowly backing out of a driveway into the street and into the path of an approaching car; Q13C – backing out of a garage and there is a child immediately under the rear bumper; Q13F – backing into a parallel parking space where you have to back very close to the car behind you. A higher percentage of older owners tended to say that they didn't know and a higher percentage of older owners said that their systems would work "Not at all" for these scenarios.
- Were less likely to report that they unintentionally backed into something or had a close call while driving their vehicles as compared to younger system owners. (Older respondents also were less likely than younger respondents to report that they had a backing collision or close call while driving another vehicle without a backing aid system because they expected a warning.)
- Agreed less strongly that the sounds made by the backing aid system were easy to hear.
- Were more likely to disagree (and strongly disagree) that they tend to use their mirrors less often than they would if they didn't have the backing aid system.
- Were more likely to disagree that they are more willing to park in small or difficult parking spaces when they use the backing aid.
- Agreed less strongly that the system gives alerts with enough time to avoid hitting an obstacle.
- Tended to disagree more strongly than younger drivers that the backing aid gives too many false warnings.
- Were less likely than younger drivers to say that they "rely on the backing aid system more now than I did in the beginning."
- Were less likely to say that the backing aid system should be improved.

On the rear-view camera survey, older respondents:

- Tended to be men, and younger camera owners tended to be women.
- Were more likely to have learned how to operate their systems from the owner's manual. (A higher percentage of younger respondents learned to use their systems from on-road experience and practice.)
- Were less likely to say that the system was very easy to learn to use, and were more likely to say that there were things that were especially difficult to learn (e.g., judging distance).
- Were less likely to admit that in the last two weeks they had backed up using just the camera monitor without checking the mirrors or turning to look out the rear window.

- Were more likely than younger respondents to say that they didn't know how well their cameras work in fog, cold, and rain, and were less likely to say that they work fairly well or perfectly for these conditions.
- Were less likely to say that it is "very easy" to use the rear-view camera when backing out of a driveway.
- Were less likely than younger respondents to say that they used the rear-view camera more now than when they first got the vehicle, and they were more likely than younger respondents to say that their usage had stayed the same.
- Were less likely to strongly agree that the rear-view camera screen is in a location where it is easy to see when backing.
- Were less likely to agree or strongly agree that they are more willing to park in small or difficult parking spaces when using the rear-view camera.
- Were less likely to strongly agree with the statement that "it is easy to tell how close I am to an obstacle by looking at the rear-view camera display."
- Were more likely to be bothered by sun glare on the camera's video display, making it hard for them to see objects or people.
- Were less likely to strongly disagree or disagree that the image contrast level is poor in the camera, making it difficult to see something or someone who may be in a shadow area behind the vehicle.
- Were less likely to say that having rear-view cameras makes them safer drivers.

Study Limitations

The survey methodology used in this study was an efficient way to assess a large number of drivers' perceptions about backing aids and rear-view camera 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 impacting 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 mail-out questionnaires sent 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.

- In this study, no attempt was made to obtain a nationally representative sample. It is likely that ACSC members 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. For example, items that addressed the perceived effectiveness of the technologies in snow or cold temperatures may get very different responses from vehicle owners living in colder climates. The characteristics of the sample obtained should be considered carefully if the results are generalized.

- The response rates for the backing aid survey and the rear-view camera survey were approximately 30 percent. This is considered to be a rather high response 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, a telephone call, or the offering of an incentive to participate.

- Based on the data from the backing aid survey and rear-view camera survey, certain changes over time in system usage, behavioral adaptations, system knowledge, and owners' opinions may be inferred if they were significantly related to the level of experience with the system. However, level of experience was measured indirectly by asking respondents how many miles they had driven the vehicle, rather than asking them how much they had used the system. It is possible that there are large differences in cumulative system usage between drivers who have similar levels of experience with the vehicle. Also, this study used a cross-sectional approach as opposed to tracking individual drivers across time. That is, the survey yielded a range of driver experience levels allowing comparisons between these groups and providing a basis for interpreting how behavior and knowledge with these systems changed across time as cumulative usage of the system increased. Behavioral adaptations, for example, were examined primarily by comparing groups of drivers with different experience levels. A weakness of the cross sectional approach is that it is difficult to make firm conclusions about the effects of experience over time for individuals. It is possible that drivers who tend to keep their vehicles longer (and therefore have more experience) are different in many ways from drivers who get a new vehicle every year. Another issue is that drivers with the higher levels of experience tend to have older vehicles possibly with earlier versions of the technologies. Only one survey item assessed behavioral changes by having individual drivers make judgments about their own system interactions over time (e.g., How has your usage of the rear-view camera changed since you first got the vehicle?). Responses to this item depended upon an individual's memory and ability to recall information. Future work should follow specific individuals across time to examine how system usage changes and behavioral adaptations develop.

Implications

- Educational efforts should be undertaken to improve vehicle owners' understanding of the limitations of their backing aid systems and rear-view cameras. Relying on the owner's manual to communicate information about system limitations is not an effective strategy. Also, given the system limitations and consumers' tendency to overestimate their safety benefits, it would be helpful if the current generation of backing aid (park aid) systems were marketed in ways that do not portray them as safety systems.

- Rear (and side) collision avoidance technology should be developed which can detect all types of obstacles including pedestrians, small children, and pets. At the same time, vehicle designers should consider ways to limit the extent of blind spots around the vehicle so that drivers do not have to increasingly depend on technology.

- Research should be undertaken to determine drivers' backing performance using rear-view camera systems under a variety of lighting conditions both inside and outside of the vehicle. Older drivers in particular should be studied because some may have particular difficulty seeing obstacles on the rear-view camera screen.

- Combining rear-view video and sensor-based object may provide the best information to drivers. Some means to help drivers estimate distance to obstacles and their backing heading within the video image would be useful for most users.

- Further research, including longitudinal research, should be undertaken to understand how drivers modify their behavior resulting from the use of backing aids and rear-view cameras. The present survey suggests that drivers rely more on technology as they gain greater experience, and at least some respondents were concerned that they may rely on the technology too much.

- Further research on the possible effects of cold temperatures and other adverse weather conditions (i.e., snow) is needed because the present sample of southern California drivers had only limited experience with these conditions.

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APPENDIX A: MAIL-OUT SURVEY INSTRUMENTS AND RECRUITMENT LETTERS

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 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 all Club 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. Please take a few minutes to fill out the attached survey and mail it back in its pre-paid envelope. This survey covers:

- Backing Aid Systems – that let drivers know, by sounds, lights, or symbols when they're getting too close to cars or other obstacles in back of them while backing.

Please let us know, by filling out the attached questionnaire, whether your «Model_Yr» «Manufacturer», with Vehicle Identification Number «VIN» has a backing aid system and what your experience has been with it. Even if your vehicle does not have a backing aid system, you can still provide us with valuable input because you drive a recent model vehicle.

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,

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

«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. Do you have any physical conditions which make driving more difficult?

(check boxes for <u>all</u> that apply)

Vision problems ..... ☐
Hearing problems ..... ☐
Difficulty turning my head/neck ..... ☐
Other *(explain)*: _____ ☐
None ..... ☐

4. A <u>backing aid system</u> helps the driver back up by providing sounds, lights or symbols when the vehicle is near an obstacle. Does your vehicle have a system like this? (If you have <u>only</u> a rear-view camera, please answer "No").

(circle one) Yes → Go to question 5 on next page
No → Answer questions 4a and 4b, then go to question 25.

4a. If <u>no</u>, then why not?

(check boxes for <u>all</u> that apply)

It never occurred to me to look for one when I was buying the vehicle..... ☐
It was not an option on my vehicle ..... ☐
I thought it would be a nuisance or distraction ..... ☐
I wouldn't trust the backing aid system to give me warnings when I need them..... ☐
I don't need a backing aid system because I have good backing skills ..... ☐
The backing aid was not worth the extra cost ..... ☐
The backing aid was 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..... ☐

4b. If you purchased this same vehicle again would you want the backing aid system?
(circle one) Yes No Don't Know

Please go to question 25.

(OVER)

5. If you purchased this same vehicle again would you want the backing aid system?
(circle one) Yes No Don't Know

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

7. How did you learn to use your vehicle's backing aid system?
(check boxes for <u>all</u> that apply)

Instructions from the dealership, such as a video, brochure, or demonstration ..... ☐
Vehicle owner's manual ..... ☐
Help from a friend or relative ..... ☐
Information on the Internet ..... ☐
On-road experience and practice (trial and error) ..... ☐
I have not yet learned how to use the backing aid ..... ☐

8. Are you aware of any warnings or limitations about your vehicle's backing aid system?
(circle one) Yes No

(If <u>yes</u>, please explain): _____
_____

9. How easy was it to learn how to use your vehicle's backing aid system to judge the distance to objects behind your vehicle? *(circle one)*

Very easy to learn 1
Somewhat easy to learn 2
Somewhat difficult to learn 3
Very difficult to learn 4
I have not tried to learn how to use the backing aid 5
I do not want to learn how to use the backing aid 6

10. Were there things that were especially difficult to learn about your vehicle's backing aid system? *(circle one)* Yes No

(If <u>yes</u>, please explain): _____
_____

11. In the last two weeks, did you ever use just the backing aid system when backing without checking the mirrors or turning to look out the rear window?
(circle one) Yes No

12. Imagine that your vehicle's backing aid system broke down. How would your driving behavior change if you could not use your vehicle's backing aid system anymore?
(check boxes for <u>all</u> that apply)

I would back up much more slowly ..... ☐
I would avoid parking places where I would have to back up ..... ☐
I would not try to fit into tight parking spaces ..... ☐
I would rely more on my mirrors and/or glances over my shoulder to see what is behind my vehicle ..... ☐
My driving behavior would not change ..... ☐
Other *(specify)*:_____ ☐

13. Please rate how well the backing aid would assist you to avoid colliding under the following circumstances. *(circle one response for each row)*

	Not at all	Poorly	Fairly Well	Perfectly	Don't Know
A. You are slowly backing out of a driveway into the street. There is a car that you can't see approaching on the street as you begin to back into its path.	1	2	3	4	DK
B. You are backing quickly down a long driveway, going about 10 mph. There is a bicycle behind the vehicle that you didn't see.	1	2	3	4	DK
C. You begin to back out of a garage and there is a child immediately under the rear bumper.	1	2	3	4	DK
D. You are slowly backing out of a parking space and there is a pedestrian standing 10 feet behind your rear bumper.	1	2	3	4	DK
E. You are backing up to a narrow sign post.	1	2	3	4	DK
F. You are backing into a parallel parking space. The space is tight and you have to back very close to the car behind you.	1	2	3	4	DK

14. How well does your vehicle's backing aid system work in the following weather conditions? *(circle one response for each row)*

	Not at all	Poorly	Fairly Well	Perfectly	Don't Know
A. Darkness	1	2	3	4	DK
B. Fog	1	2	3	4	DK
C. Cold temperatures	1	2	3	4	DK
D. Rain	1	2	3	4	DK
E. Snow	1	2	3	4	DK
F. Bright sun	1	2	3	4	DK

Are there any other conditions where your vehicle's backing aid system does <u>not</u> work well?
(Explain): _____
_____

(OVER)

15. If your vehicle's backing aid system has both lights/symbols and sounds, which do you rely on more?

(circle one)

My system does not have any lights/symbols 1
My system does not have any sounds 2
I rely on the lights/symbols more than the sounds 3
I rely on the sounds more than the lights/symbols 4
I rely on the lights/symbols and sounds about equally 5

16. Have you ever unintentionally backed into something or had a "close call" since you started driving this vehicle?

(circle one) Yes No

(If <u>yes</u>, please describe the situation):

_____
_____
_____
_____
_____
_____
_____
_____

17. Since you have owned this vehicle, have you driven <u>another vehicle without a backing aid system</u> and backed into something or had a "close call" because you expected the vehicle to give you a warning?

(circle one) Yes No

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

(circle one response for each row)

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Not Applicable
A. It's easy to hear the sounds made by the backing aid system.	1	2	3	4	5	NA
B. It's easy to see the lights/symbols on the backing aid system.	1	2	3	4	5	NA
C. When I use the backing aid, I use my mirrors less often than I would if I did not have the backing aid.	1	2	3	4	5	NA
D. When I use the backing aid, I look over my shoulder less often than I would if I did not have the backing aid.	1	2	3	4	5	NA
E. I am more confident in my ability to detect pedestrians when I use the backing aid.	1	2	3	4	5	NA
F. I am more willing to park in small or difficult parking spaces when I use the backing aid.	1	2	3	4	5	NA
G. The backing aid gives me a good idea of my distance from an obstacle.	1	2	3	4	5	NA
H. The backing aid gives alerts with enough time to avoid hitting an obstacle.	1	2	3	4	5	NA
I. The backing aid gives too many false warnings when I am not in danger of hitting anything.	1	2	3	4	5	NA
J. The backing aid fails to warn me about an obstacle when it should have.	1	2	3	4	5	NA

(OVER)

19. How has your reliance on the backing aid system changed since you first got the vehicle?

(circle one)

I rely on it more now than I did in the beginning 1
Why? _____
I rely on it less now than I did in the beginning 2
Why? _____
My reliance has stayed about the same 3

20. Have you ever received an unexpected warning when backing because you didn't know what was behind your vehicle?

(circle one) Yes No

If yes, then how did you react the last time this happened?

(circle one)

I got out of the vehicle and checked for obstacles 1
I stopped immediately and checked my mirrors and/or looked out the rear window before continuing to back up 2
I slowed down and looked for the obstacle before stopping 3
I ignored the warning because I was sure that there wasn't any obstacle behind me 4

If yes, what was the reason for the last unexpected warning?

(circle one)

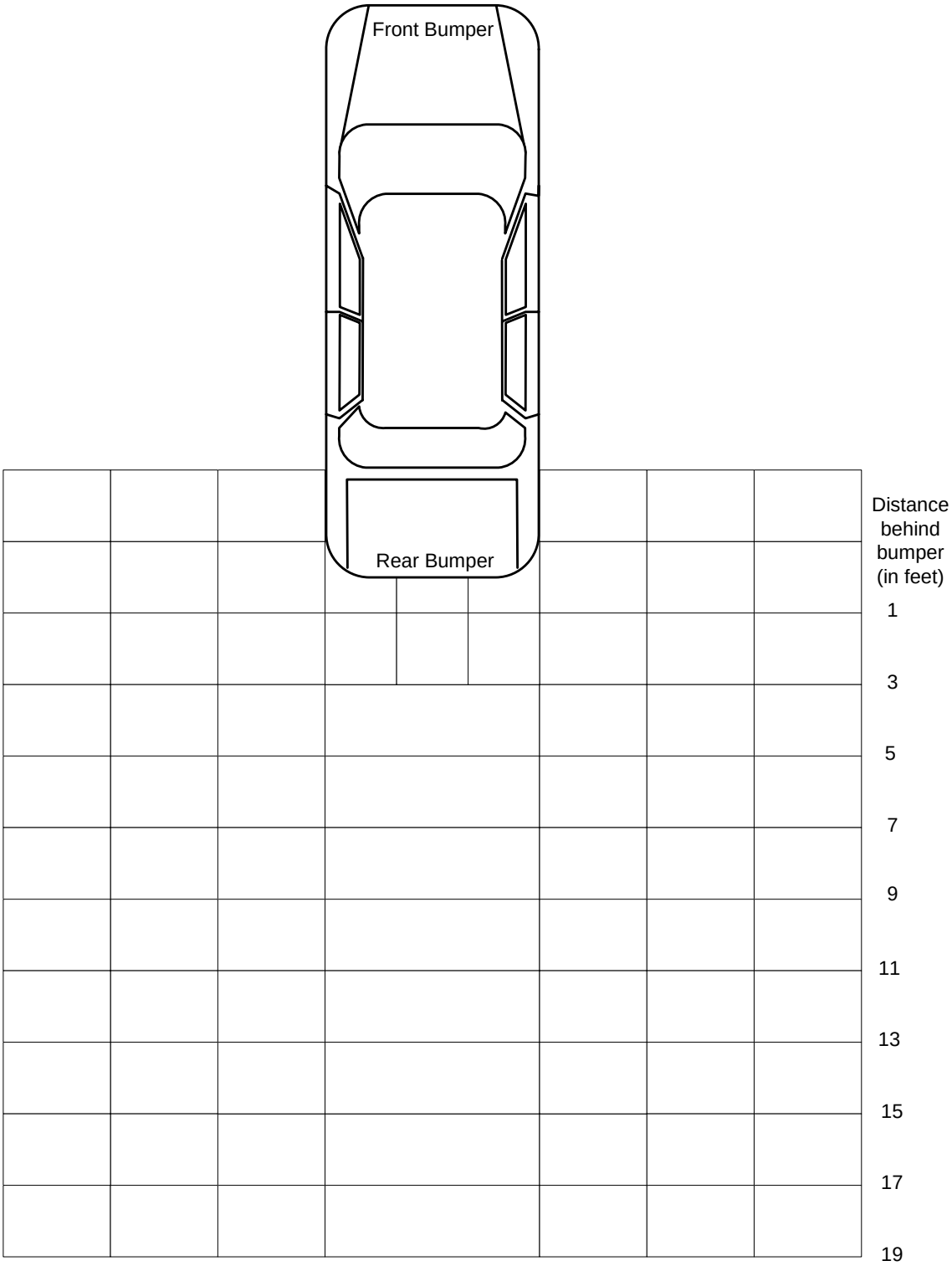
It was nothing that I could identify 1
It was another vehicle 2
It was a person 3
It was a pole, post, or tree 4
It was a curb 5
It was some other object on the ground 6

21. Overall, does having the backing aid make you a safer driver?

(circle one)

Yes, safer 1
Neither more nor less safe 2
No, less safe 3

22. Suppose that the diagram below shows an overhead view of your vehicle. Based on your experience, write an "X" in all rectangles where you think your backing aid system <u>would detect</u> a small child and give you a warning.



(OVER)

23. Does using the backing aid create any new driving problems or safety concerns for you?

(circle one) Yes No

(If yes, please explain): _____
_____

24. Is there anything about the way that the backing aid system works that you think should be improved?

(circle one) Yes No

(If yes, please explain): _____
_____

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

(circle one) Yes No

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

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 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 all Club 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. Please take a few minutes to fill out the attached survey and mail it back in its pre-paid envelope. This survey covers:

- Rear-View Video Cameras – that let drivers see cars and other obstacles behind them while backing.

Please let us know, by filling out the attached questionnaire, whether your «Model_Yr» «Manufacturer», with Vehicle Identification Number «VIN» has this safety item and what your experience has been with it. Even if your vehicle does not have a rear-view video camera, you can still provide us with valuable input because you drive a recent model vehicle.

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,

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

«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. Do you have any physical conditions which make driving more difficult?

(check boxes for <u>all</u> that apply)

Vision problems ..... ☐
Hearing problems ..... ☐
Difficulty turning my head/neck ..... ☐
Other *(explain):* _____ ☐
None ..... ☐

4. A <u>rear-view video camera</u> shows the driver the area behind the vehicle when you are backing on a screen inside the vehicle. Does your vehicle have a rear-view video camera?

(circle one) Yes → Go to question 5 on next page
No → Answer questions 4a and 4b, then go to question 24.

4a. If <u>no</u>, then why not?

(check boxes for <u>all</u> that apply)

It never occurred to me to look for one when I was buying the vehicle ..... ☐
The rear-view camera was not an option on my vehicle ..... ☐
I thought the rear-view camera would be a nuisance or distraction ..... ☐
I wouldn't trust the rear-view camera ..... ☐
I don't need a rear-view camera because I have good backing skills ..... ☐
The rear-view camera was not worth the extra cost ..... ☐
The rear-view camera was only available with other options I didn't want ..... ☐
I was not the person who purchased or made the decision to purchase this vehicle ..... ☐

4b. If you purchased this same model vehicle again would you want a rear-view camera?

(circle one) Yes No Don't Know

Please go to question 24.

(OVER)

5. If you purchased this same model vehicle again would you want a rear-view camera?
(circle one) Yes No Don't Know

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

7. How did you learn to use your vehicle's rear-view camera?
(check boxes for <u>all</u> that apply)

Instructions from the dealership, such as a video, brochure, or demonstration ..... ☐
Vehicle owner's manual ..... ☐
Help from a friend or relative ..... ☐
Information on the Internet ..... ☐
On-road experience and practice (trial and error) ..... ☐
I have not yet learned how to use the rear-view camera ..... ☐

***8.* Are you aware of any warnings or limitations about your vehicle's rear-view camera?**
(circle one) Yes No

(If <u>yes</u>, please explain): _____
_____

9. How easy was it to learn how to use your vehicle's rear-view camera to judge the distance to objects behind your vehicle? *(circle one)*

Very easy to learn 1
Somewhat easy to learn 2
Somewhat difficult to learn 3
Very difficult to learn 4
I have not tried to learn how to use the rear-view camera 5
I do not want to learn how to use the rear-view camera 6

10. Were there things that were especially difficult to learn about your vehicle's rear-view camera? *(circle one)* Yes No

(If <u>yes</u>, please explain): _____
_____

11. In the last two weeks, did you ever use just the camera when backing without checking the mirrors or turning to look out the rear window?
(circle one) Yes No

12. Which of the following best describes how much you normally pay attention to the rear-view camera when backing? *(circle one)*

I rarely or never look at it 1
I usually just take a quick glance at the camera screen to determine if I can back up 2
I share my attention about equally between the rear-view camera screen and my mirrors or direct glances out the rear window 3
I pay attention to the rear-view camera screen more than to my mirrors and glances over my shoulder 4
I usually back up the vehicle using only the camera. I don't feel that I need to check mirrors or look out the rear windows 5

13. Imagine that your vehicle's rear-view camera broke down. How would your driving behavior change if you could not use your vehicle's rear-view camera anymore?

(check boxes for all that apply)

I would back up much more slowly ..... ☐
I would avoid parking in places where I would have to back up ..... ☐
I would not try to fit into tight parking spaces ..... ☐
I would rely more on my mirrors and/or glances over my shoulder to see what's behind my vehicle ..... ☐
My driving behavior would not change ..... ☐
Other *(specify)*: _____ ☐

14. If your vehicle's rear-view camera display has lines, graphics, or text information on the screen, do you find these useful? *(circle one)*

My system does not show any other information on the screen, only the rear-view video image 1
Yes, they are useful for… *(explain)*: _____ _____ 2
No, they are not useful *(explain)*: _____ _____ 3

15. How well does your vehicle's rear-view camera work in the following weather conditions?

(circle one response for each row)

	Not at all	Poorly	Fairly Well	Perfectly	Don't Know
A. Darkness	1	2	3	4	DK
B. Fog	1	2	3	4	DK
C. Cold temperatures	1	2	3	4	DK
D. Rain	1	2	3	4	DK
E. Snow	1	2	3	4	DK
F. Bright sun	1	2	3	4	DK

Are there any other conditions where your vehicle's rear-view camera does not work well?
(Explain): _____
_____

16. Overall, how easy is the rear-view camera to use when backing out of a driveway?

(circle one)

Very easy to use 1
Somewhat easy to use 2
Somewhat difficult to use 3
Very difficult to use 4
Don't know 5

17. How has your usage of the rear-view camera changed since you first got the vehicle?

(circle one)

I use it more now than I did in the beginning..... 1

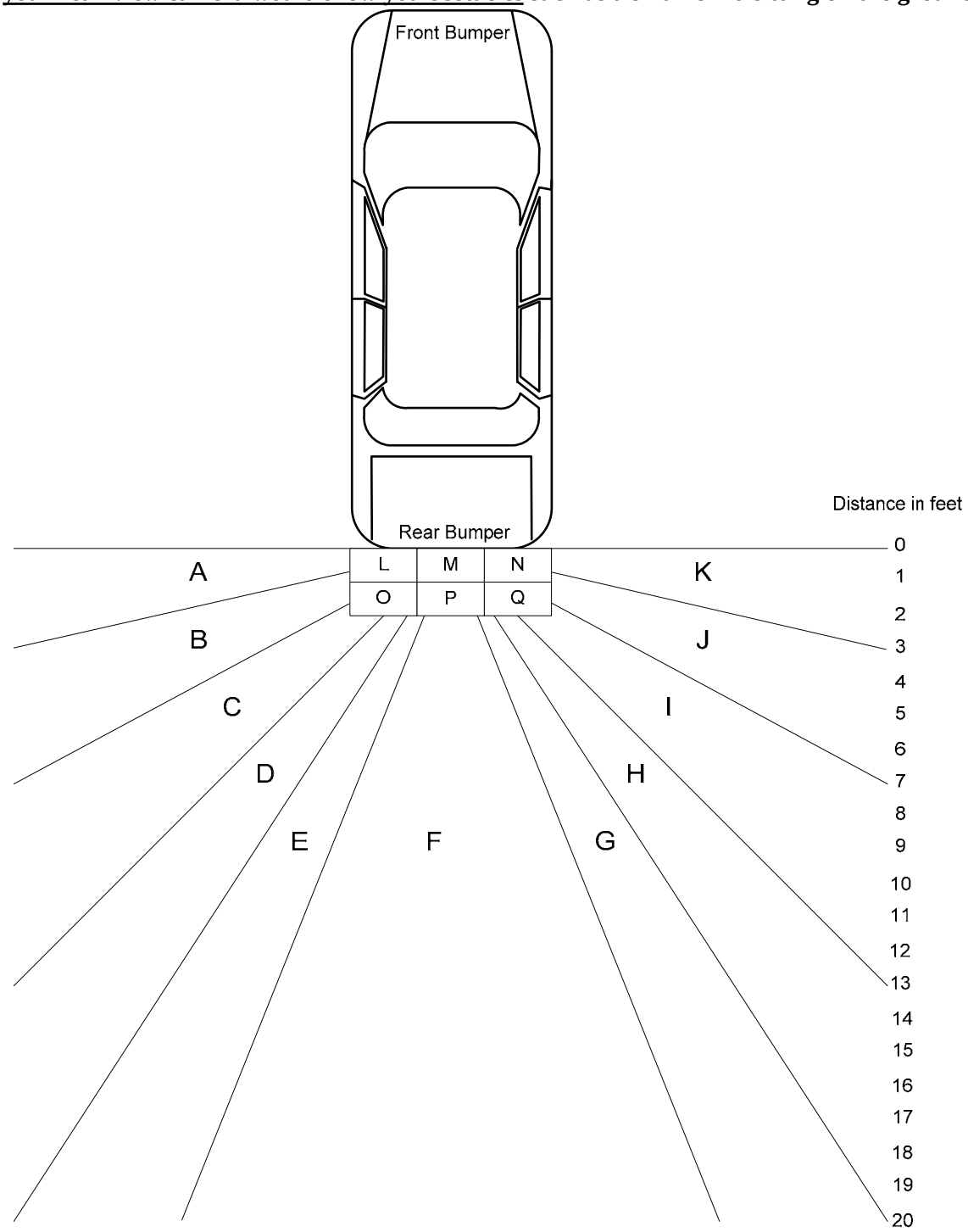
i. Why? _____

I use it less now than I did in the beginning..... 2

ii. Why? _____

My usage has stayed about the same..... 3

18. Suppose that the diagram below shows an overhead view of your vehicle and areas labeled "A" – "Q". Based on your experience, please circle the letters for <u>all areas where your rear-view camera would show you obstacles</u> such as a small child sitting on the ground.



19. 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
A. The rear-view camera screen is in a location where it is easy to see when I am backing	1	2	3	4	5
B. I am more confident in my backing abilities when I use the rear-view camera	1	2	3	4	5
C. I am more willing to park in small or difficult parking spaces when I use the rear-view camera	1	2	3	4	5
D. It's easy to tell how close I am to an obstacle by looking at the rear-view camera display	1	2	3	4	5
E. The rear-view camera <u>does not</u> show the entire area behind the vehicle that I need to see when backing, in other words, there is a blind spot	1	2	3	4	5
F. The rear-view camera display gets blurry or hard to see if I am moving	1	2	3	4	5
G. The rear-view camera gets dirty and makes obstacles hard to see	1	2	3	4	5
H. Sun glare on the video display makes it hard for me to see objects or people.	1	2	3	4	5
I. It's hard to distinguish something or someone who may be in a shadow area behind my vehicle (Image contrast level is poor in camera)	1	2	3	4	5
J. My risk of hitting somebody while backing is lower with the rear-view camera than without it	1	2	3	4	5

(OVER)

20. Have you ever unintentionally backed into something or had a "close call" since you started driving this vehicle?

(circle one) Yes No

(If yes, were you using the camera at the time? Please describe the situation):

_____

_____

_____

21. Does using the rear-view camera create any new driving problems or safety concerns for you?

(circle one) Yes No

(If yes, please explain): _____

_____

22. Overall, does having the rear-view camera make you a safer driver?

(circle one)

Safer 1
Neither more nor less safe 2
Less safe 3

23. Is there anything about the rear-view camera that you think should be improved?

(circle one) Yes No

(If yes, please explain): _____

_____

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

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 BACKING AID SYSTEMS

The following list shows the response frequencies for each item on the backing aid 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 5,000 backing aid questionnaires mailed out, 1,537 questionnaires were returned within 3 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 Backing Aid	Percentage With Backing Aid
2001	149	9.68	89	8.19
2002	164	10.67	108	9.94
2003	332	21.60	248	22.82
2004	442	28.76	316	29.07
2005	413	26.87	302	27.78
2006	37	2.41	24	2.21
Total	1,537	100.00	1087	100.00

Vehicle manufacturer

Description	Count	Percentage	Count With Backing Aid	Percentage With Backing Aid
Acura	53	3.45	5	0.46
Audi	9	0.59	3	0.28
BMW	92	5.99	43	3.96
Buick	79	5.14	50	4.60
Cadillac	310	20.17	257	23.64
Chevrolet	28	1.82	12	1.10
Chrysler	23	1.50	17	1.56
Ford	204	13.27	131	12.05
Honda	20	1.30	18	1.66
Jaguar	208	13.53	194	17.85
Jeep	2	0.13	0	0.00
Land Rover	11	0.72	10	0.92
Lincoln	216	14.05	204	18.77

Mercedes-Benz	53	3.45	13	1.20
Mercury	39	2.54	26	2.39
Mini	14	0.91	6	0.55
Nissan	48	3.12	33	3.04
Oldsmobile	9	0.59	2	0.18
Pontiac	2	0.13	0	0.00
Porsche	8	0.52	4	0.37
Saab	1	0.07	0	0.00
Toyota	96	6.25	52	4.78
Volkswagen	1	0.07	1	0.09
Volvo	11	0.72	6	0.55
Total	1,537	100.00	1087	100.00

Q1. Age (self-reported)

Description	Count	Percentage	Count With Backing Aid	Percentage With Backing Aid
18 - 34 years	88	5.87	54	5.09
35 - 44 years	149	9.94	105	9.91
45 - 54 years	170	11.34	118	11.13
55 - 64 years	155	10.34	108	10.19
65 - 74 years	442	29.49	317	29.91
75 years or older	495	33.02	358	33.77
Subtotal Valid Responses	1,499	100.00	1,060	100.00
Not Ascertained	38		27	
Total	1,537		1,087	

Q2. Gender

Category	Description	Count	Percentage	Count With Backing Aid	Percentage With Backing Aid
1	Male	935	62.25	654	61.58
2	Female	567	37.75	408	38.42
	Subtotal Valid Responses	1,502	100.00	1,062	100.00
9	Not Ascertained	35		25	
	Total	1,537		1,087	

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

Category	Description	Count	Percentage	Count With Backing Aid	Percentage With Backing Aid
1	Vision problems	87	6.60	54	5.82
2	Hearing problems	76	5.76	58	6.25
3	Difficulty turning my head/neck	88	6.67	64	6.90
4	Other conditions	10	0.76	7	0.75
5	None	1,109	84.08	783	84.38
	Subtotal Valid Responses	1,370		966	
	Total Respondents	1,319	100.00	928	100.00
9	Not Ascertained	218		159	

Q3. Other physical condition (explain).

Category	Description	Count	Percentage	Count With Backing Aid	Percentage With Backing Aid
1	*Physically handicapped*	1	10.00	1	14.29
2	*Physical size*	2	20.00	0	0.00
3	*Joint problems*	1	10.00	1	14.29
94	*Other*	4	40.00	3	60.00
	Subtotal Valid Responses	8	80.00	5	71.43
	Total respondents who responded “other” in Q3.	10	100.00	7	100.00
96	Text response not reported	2	20.0	2	

Q4. A backing aid system helps the driver back up by providing sounds, lights, or symbols when the vehicle is near an obstacle. Does your vehicle have a system like this?

Category	Description	Count	Percentage
1	Yes	1087	70.77
2	No	449	29.23
	Subtotal Valid Responses	1,536	100.00
9	Not Ascertained	1	
	Total	1,537	

Q4a. If no, then why not?

Category	Description	Count	Percentage
1	It never occurred to me to look for one when I was buying the vehicle.	210	49.41
2	It was not an option on my vehicle.	250	58.82
3	I thought it would be a nuisance or distraction.	13	3.06
4	I wouldn't trust the backing aid system to give me warnings when I need them.	27	6.35
5	I don't need a backing aid system because I have good backing skills.	56	13.18
6	The backing aid was not worth the extra cost.	38	8.94
7	The backing aid was only available with other options that I didn't want.	38	8.94
8	I was not the person who purchased or made the decision to purchase this vehicle.	34	8.00
	Subtotal Valid Responses	666	
	Total Respondents	425	100.00
9	Not Ascertained	24	

Q4b. If you purchased this same vehicle again would you want the backing aid system? (For vehicle owners who do not have a backing aid system)

Category	Description	Count	Percentage
1	Yes	227	51.95
2	No	76	17.39
8	Don't Know	134	30.66
	Subtotal Valid Responses	437	100.00
9	Not Ascertained	12	
	Total	449	

Q5. If you purchased this same vehicle again would you want the backing aid system? (For vehicle owners who currently have a backing aid system)

Category	Description	Count	Percentage
1	Yes	1048	98.31
2	No	9	0.84
8	Don't Know	9	0.84
	Subtotal Valid Responses	1,066	100.00
9	Not Ascertained	21	
	Total	1,087	

Q6. Approximately how many miles have you personally driven this vehicle?

Category	Description	Count	Percentage
	(< 5,000 miles)	124	12.61
	(5,000 to 9,999)	155	15.77
	(10,000 to 19,999)	295	30.01
	(20,000 to 29,999)	186	18.92
	(30,000 to 39,999)	94	9.56
	(40000 to 49,999)	54	5.49
	(>=50,000 miles)	75	7.63
	Subtotal Valid Responses	983	100.00
	Don't Know (written on form)	2	
	Not Ascertained	102	
	Total	1,087	

Q7. How did you learn to use your vehicle's backing aid system?

Category	Description	Count	Percentage
1	Instructions from the dealership, such as video, brochure, or demonstration	470	45.32
2	Vehicle owner's manual	451	43.49
3	Help from a friend or relative	36	3.47
4	Information on the Internet	8	0.77
5	On-road experience and practice (trial and error)	565	54.48
6	I have not yet learned how to use the backing aid	12	1.16
	Subtotal Valid Responses	1,542	
	Total Respondents	1,037	100.00
9	Not Ascertained	47	

Q8. Are you aware of any warnings or limitations about your vehicle's backing aid system?

Category	Description	Count	Percentage
1	Yes	212	20.52
2	No	821	79.48
	Subtotal Valid Responses	1,033	100.00
9	Not Ascertained	54	
	Total	1,087	

Q8. If yes, please explain.

Category	Description	Count	Percentage
1	*Close to or under the bumper*	9	4.24
2	*Low lying object*	13	6.13
3	*Blind spots*	10	4.72
4	*Distance limitation*	31	14.62
5	*Alarm is not loud enough*	3	1.42
94	*Other*	70	33.02
	Subtotal Valid Responses	136	64.15
	Total respondents who answered “yes” to Q8.	212	100.00
95	Response did not pertain to the question	30	
96	Text response not reported	46	

Q9. How easy was it to learn how to use your vehicle's backing aid system to judge the distance to objects behind your vehicle?

Category	Description	Count	Percentage
1	Very easy to learn	876	84.15
2	Somewhat easy to learn	141	13.54
3	Somewhat difficult to learn	17	1.63
4	Very difficult to learn	0	0.00
5	I have not tried to learn how to use the backing aid	6	0.58
6	I do not want to learn how to use the backing aid	1	0.10
	Subtotal Valid Responses	1,041	100.00
9	Not Ascertained	46	
	Total	1,087	

Q10. Were there things that were especially difficult to learn about your vehicle's backing aid system?

Category	Description	Count	Percentage
1	Yes	39	3.79
2	No	990	96.21
	Subtotal Valid Responses	1,029	100.00
8	Don't Know (written on form)	1	
9	Not Ascertained	57	
	Total	1,087	

Q10. If yes, please explain.

Category	Description	Count	Percentage
1	*Distance to object*	9	23.08
2	*Understanding of the meaning of "beeps"*	9	23.08
94	*Other*	14	35.90
	Subtotal Valid Responses	32	82.05
	Total respondents who answered “yes” to Q10.	39	100.00
95	Response did not pertain to the question	2	
96	Text response not reported	5	

Q11. In the last two weeks, did you ever use just the backing aid system when backing without checking the mirrors or turning to look out the rear window?

Category	Description	Count	Percentage
1	Yes	122	11.66
2	No	924	88.34
	Subtotal Valid Responses	1,046	100.00
9	Not Ascertained	41	
	Total	1,087	

Q12. Imagine that your vehicle’s backing aid system broke down. How would your driving behavior change if you could not use your vehicle's backing aid system anymore?

Category	Description	Count	Percentage
1	I would back up much more slowly	424	40.38
2	I would avoid parking places where I would have to back up	94	8.95
3	I would not try to fit into tight parking spaces	178	16.95
4	I would rely more on my mirrors and/or glances over my shoulder to see what is behind my vehicle	636	60.57
5	My driving behavior would not change	367	34.95
6	Other	41	3.90
	Subtotal Valid Responses	1,740	
	Total Respondents	1,050	100.00
9	Not Ascertained	37	

Q12. Other (specify)

Category	Description	Count	Percentage
1	*Do an external visual check before backing*	10	24.39
94	*Other*	23	56.10
	Subtotal Valid Responses	33	80.49
	Total Respondents who answered “other” to Q12.	41	100.00
95	Response did not pertain to question	6	
96	Text response not reported	2	

Q13. Please rate how well the backing aid would assist you to avoid colliding under the following circumstances?

Q13a. You are slowly backing out of a driveway into the street. There is a car that you can’t see approaching on the street as you begin to back into its path.

Category	Description	Count	Percentage
1	Not At All	262	25.31
2	Poorly	101	9.76
3	Fairly Well	303	29.28
4	Perfectly	244	23.57
8	Don't Know	125	12.08
	Subtotal Valid Responses	1,035	100.00
9	Not Ascertained	52	
	Total	1,087	

Q13b. You are backing quickly down a long driveway, going about 10 mph. There is a bicycle behind the vehicle that you didn't see.

Category	Description	Count	Percentage
1	Not At All	84	8.14
2	Poorly	106	10.27
3	Fairly Well	312	30.23
4	Perfectly	388	37.60
8	Don't Know	142	13.76
	Subtotal Valid Responses	1,032	100.00
9	Not Ascertained	55	
	Total	1,087	

Q13c. You begin to back out of a garage and there is a child immediately under the rear bumper.

Category	Description	Count	Percentage
1	Not At All	177	17.15
2	Poorly	59	5.72
3	Fairly Well	171	16.57
4	Perfectly	376	36.43
8	Don't Know	249	24.13
	Subtotal Valid Responses	1,032	100.00
9	Not Ascertained	55	
	Total	1,087	

Q13d. You are slowly backing out of a parking space and there is a pedestrian standing 10 feet behind your rear bumper.

Category	Description	Count	Percentage
1	Not At All	72	6.99
2	Poorly	60	5.83
3	Fairly Well	280	27.18
4	Perfectly	523	50.78
8	Don't Know	95	9.22
	Subtotal Valid Responses	1,030	100.00
9	Not Ascertained	57	
	Total	1,087	

Q13e. You are backing up to a narrow sign post.

Category	Description	Count	Percentage
1	Not At All	17	1.64
2	Poorly	45	4.34
3	Fairly Well	326	31.47
4	Perfectly	577	55.69
8	Don't Know	71	6.85
	Subtotal Valid Responses	1,036	100.00
9	Not Ascertained	51	
	Total	1,087	

Q13f. You are backing into a parallel parking space. The space is tight and you have to back very close to the car behind you.

Category	Description	Count	Percentage
1	Not At All	14	1.35
2	Poorly	16	1.54
3	Fairly Well	267	25.70
4	Perfectly	703	67.66
8	Don't Know	39	3.75
	Subtotal Valid Responses	1,039	100.00
9	Not Ascertained	48	
	Total	1,087	

Q14. How well does your vehicle's backing aid system work in the following weather conditions?

Q14a. Darkness

Category	Description	Count	Percentage
1	Not At All	3	0.29
2	Poorly	10	0.96
3	Fairly Well	212	20.44
4	Perfectly	712	68.66
8	Don't Know	100	9.64
	Subtotal Valid Responses	1,037	100.00
9	Not Ascertained	50	
	Total	1,087	

Q14b. Fog

Category	Description	Count	Percentage
1	Not At All	5	0.48
2	Poorly	13	1.26
3	Fairly Well	128	12.42
4	Perfectly	525	50.92
8	Don't Know	360	34.92
	Subtotal Valid Responses	1,031	100.00
9	Not Ascertained	56	
	Total	1,087	

Q14c. Cold Temperatures

Category	Description	Count	Percentage
1	Not At All	6	0.58
2	Poorly	5	0.49
3	Fairly Well	147	14.29
4	Perfectly	588	57.14
8	Don't Know	283	27.50
	Subtotal Valid Responses	1,029	100.00
9	Not Ascertained	58	
	Total	1,087	

Q14d. Rain

Category	Description	Count	Percentage
1	Not At All	4	0.39
2	Poorly	11	1.07
3	Fairly Well	190	18.41
4	Perfectly	661	64.05
8	Don't Know	166	16.09
	Subtotal Valid Responses	1,032	100.00
9	Not Ascertained	55	
	Total	1,087	

Q14e. Snow

Category	Description	Count	Percentage
1	Not At All	3	0.30
2	Poorly	13	1.28
3	Fairly Well	73	7.21
4	Perfectly	295	29.12
8	Don't Know	629	62.09
	Subtotal Valid Responses	1,013	100.00
9	Not Ascertained	74	
	Total	1,087	

Q14f. Bright Sun

Category	Description	Count	Percentage
1	Not At All	3	0.29
2	Poorly	7	0.68
3	Fairly Well	196	18.94
4	Perfectly	767	74.11
8	Don't Know	62	5.99
	Subtotal Valid Responses	1,035	100.00
9	Not Ascertained	52	
	Total	1,087	

Q14. Are there any other conditions where your backing aid system doesn't work well? Explain.

Category	Description	Count	Percentage
	Changing of light to dark or dark to light	1	2.17
	False readings	8	17.39
	Extreme angles	3	6.52
	Height of obstacle	6	13.04
	No new condition given	2	4.34
	Sensor dirty	3	6.52
	Other	18	39.13
	Subtotal Valid Responses	41	89.13
	Total Respondents	46	100.00
	Response did not pertain to question	5	

Q15. If your vehicle's backing aid system has both lights/symbols and sounds, which do you rely on more?

Category	Description	Count	Percentage
1	My system does not have any lights/symbols	349	39.21
2	My system does not have any sounds	12	1.35
3	I rely more on the lights/symbols more than the sounds	18	2.02
4	I rely on the sounds more than the lights/symbols	345	38.76
5	I rely on the lights/symbols and sounds about equally	166	18.65
	Subtotal Valid Responses	890	100.00
9	Not Ascertained	197	
	Total	1,087	

Q16. Have you ever unintentionally backed into something or had a "close call" since you started driving this vehicle?

Category	Description	Count	Percentage
1	Yes	148	14.48
2	No	874	85.52
	Subtotal Valid Responses	1,022	100.00
9	Not Ascertained	65	
	Total	1,087	

Q16. If yes, please describe the situation.

Category	Description	Count	Percentage
1	*Stationary object*	54	36.49
2	*Moving object*	28	18.92
3	*Pedestrian*	18	12.16
4	*Side of Car*	4	2.70
5	*Blind spot*	1	0.68
6	*Sensor prevented accident*	6	4.05
7	*Backed up too quickly for sensor to work*	5	3.34
94	*Other*	13	8.78
	Subtotal Valid Responses	129	87.16
	Total respondents who answered “yes” to Q16.	148	100.00
95	Response did not pertain to question	8	
96	Text response not reported	11	

Q17. Since you have owned this vehicle, have you driven another vehicle without a backing aid system and backed into something or had a close call because you expected the vehicle to give you a warning?

Category	Description	Count	Percentage
1	Yes	180	17.66
2	No	839	82.34
	Subtotal Valid Responses	1,019	100.00
9	Not Ascertained	68	
	Total	1,087	

Q18. For each of the following statements on the left, please indicate how much you agree or disagree.

Q18a. It's easy to hear the sounds made by the backing aid system.

Category	Description	Count	Percentage
1	Strongly Disagree	8	0.77
2	Disagree	6	0.58
3	Neutral	21	2.03
4	Agree	259	25.05
5	Strongly Agree	725	70.12
6	Not Applicable	15	1.45
	Subtotal Valid Responses	1,034	100.00
8	Don't Know (written on form)	1	
9	Not Ascertained	52	
	Total	1,087	

Q18b. It's easy to see the lights/symbols on the backing aid system.

Category	Description	Count	Percentage
1	Strongly Disagree	10	1.03
2	Disagree	32	3.29
3	Neutral	75	7.70
4	Agree	148	15.20
5	Strongly Agree	158	16.22
6	Not Applicable	551	56.57
	Subtotal Valid Responses	974	100.00
8	Don't Know (written on form)	3	
9	Not Ascertained	110	
	Total	1,087	

Q18c. When I use the backing aid, I use my mirrors less often than I would if I did not have the backing aid.

Category	Description	Count	Percentage
1	Strongly Disagree	326	31.87
2	Disagree	380	37.15
3	Neutral	122	11.93
4	Agree	135	13.20
5	Strongly Agree	54	5.28
6	Not Applicable	6	0.59
	Subtotal Valid Responses	1,023	100.00
9	Not Ascertained	64	
	Total	1,087	

Q18d. When I use the backing aid, I look over my shoulder less often than I would if I did not have the backing aid.

Category	Description	Count	Percentage
1	Strongly Disagree	299	28.97
2	Disagree	378	36.63
3	Neutral	115	11.14
4	Agree	173	16.76
5	Strongly Agree	60	5.81
6	Not Applicable	7	0.68
	Subtotal Valid Responses	1,032	100.00
9	Not Ascertained	55	
	Total	1,087	

Q18e. I am more confident in my ability to detect pedestrians when I use the backing aid.

Category	Description	Count	Percentage
1	Strongly Disagree	62	6.05
2	Disagree	78	7.62
3	Neutral	167	16.31
4	Agree	353	34.47
5	Strongly Agree	352	34.38
6	Not Applicable	12	1.17
	Subtotal Valid Responses	1,024	100.00
9	Not Ascertained	63	
	Total	1,087	

Q18f. I am more willing to park in small or difficult parking spaces when I use the backing aid.

Category	Description	Count	Percentage
1	Strongly Disagree	107	10.45
2	Disagree	188	18.36
3	Neutral	239	23.34
4	Agree	250	24.41
5	Strongly Agree	211	20.61
6	Not Applicable	29	2.83
	Subtotal Valid Responses	1,024	100.00
9	Not Ascertained	63	
	Total	1,087	

Q18g. The backing aid gives me a good idea of my distance from an obstacle.

Category	Description	Count	Percentage
1	Strongly Disagree	7	0.68
2	Disagree	31	3.00
3	Neutral	71	6.88
4	Agree	451	43.70
5	Strongly Agree	469	45.45
6	Not Applicable	3	0.29
	Subtotal Valid Responses	1,032	100.00
9	Not Ascertained	55	
	Total	1,087	

Q18h. The backing aid gives alerts with enough time to avoid hitting an obstacle.

Category	Description	Count	Percentage
1	Strongly Disagree	6	0.58
2	Disagree	12	1.17
3	Neutral	56	5.44
4	Agree	432	41.98
5	Strongly Agree	518	50.34
6	Not Applicable	5	0.49
	Subtotal Valid Responses	1,029	100.00
9	Not Ascertained	58	
	Total	1,087	

Q18i. The backing aid gives too many false warnings when I am not in danger of hitting anything.

Category	Description	Count	Percentage
1	Strongly Disagree	335	32.56
2	Disagree	466	45.29
3	Neutral	143	13.90
4	Agree	51	4.96
5	Strongly Agree	11	1.07
6	Not Applicable	23	2.24
	Subtotal Valid Responses	1,029	100.00
9	Not Ascertained	58	
	Total	1,087	

Q18j. The backing aid fails to warn me about an obstacle when it should have.

Category	Description	Count	Percentage
1	Strongly Disagree	406	39.46
2	Disagree	449	43.63
3	Neutral	94	9.14
4	Agree	19	1.85
5	Strongly Agree	20	1.94
6	Not Applicable	41	3.98
	Subtotal Valid Responses	1,029	100.00
9	Not Ascertained	58	
	Total	1,087	

Q19. How has your reliance on the backing aid system changed since you first got the vehicle?

Category	Description	Count	Percentage
1	I rely on it more now than I did in the beginning.	355	35.50
2	I rely on it less now than I did in the beginning.	12	1.20
3	My reliance has stayed about the same.	633	63.30
	Subtotal Valid Responses	1,000	100.00
8	Don't Know (written on form)	1	
9	Not Ascertained	86	
	Total	1,087	

Q19. I rely on it more now than I did in the beginning, why?

Category	Description	Count	Percentage
1	*Dependable*	55	15.49
2	*Confident in the system*	101	28.45
3	*Gives additional help in backing*	32	9.01
94	*Other*	16	4.51
	Subtotal Valid Responses	204	57.46
	Total respondents who responded “more” to Q19.	355	100.00
95	Response did not pertain to the question	8	
96	Text response not reported	143	

Q19. I rely on it less now than I did in the beginning, why?

Category	Description	Count	Percentage
1	*Don't feel it's reliable*	4	33.33
94	*Other*	2	16.67
	Subtotal Valid Responses	6	50.00
	Total respondents who reported “less” to Q19.	12	100.00
95	Response did not pertain to the question	1	
96	Text response not reported	5	

Q20. Have you ever received an unexpected warning when backing because you didn’t know what was behind your vehicle?

Category	Description	Count	Percentage
1	Yes	694	68.58
2	No	318	31.42
	Subtotal Valid Responses	1,012	100.00
9	Not Ascertained	75	
	Total	1,087	

Q20. If yes, then how did you react the last time this happened?

Category	Description	Count	Percentage
1	I got out of the vehicle and checked for obstacles	224	32.94
2	I stopped immediately and checked my mirrors and/or looked out the rear window before continuing to back up	434	63.82
3	I slowed down and looked for the obstacle before stopping	16	2.35
4	I ignored the warning because I was sure that there wasn't any obstacle behind me	6	0.88
	Subtotal Valid Responses	680	100.00
8	Don't Know (written on form)	1	
9	Not Ascertained	13	
	Total	694	

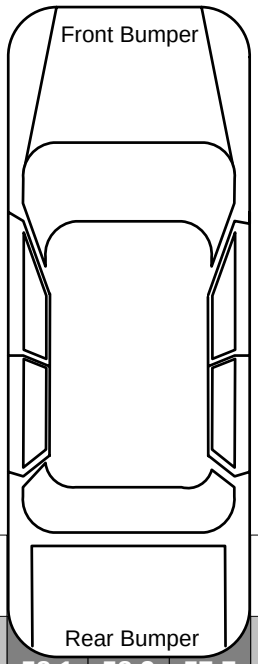
Q20. If yes, what was the reason for the last unexpected warning?

Category	Description	Count	Percentage
1	It was nothing I could identify	51	7.93
2	It was another vehicle	113	17.57
3	It was a person	118	18.35
4	It was a pole, post, or tree	164	25.51
5	It was a curb	74	11.51
6	It was some other object on the ground	123	19.13
	Subtotal Valid Responses	643	100.00
8	Don't Know (written on form)	2	
9	Not Ascertained	49	
	Total	694	

Q21. Overall, does having the backing aid make you a safer driver?

Category	Description	Count	Percentage
1	Yes, safer	836	83.02
2	Neither more nor less safe	166	16.48
3	No, less safe	5	0.50
	Subtotal Valid Responses	1,007	100.00
9	Not Ascertained	80	
	Total	1,087	

Q22. Suppose that the diagram below shows an overhead view of your vehicle. Based on your experience, write an "X" in all rectangles where you think your backing aid system would detect a small child and give you a warning.



1.0	2.8	12.5			12.7	3.0	1.3
1.4	4.3	42.3	**58.1**	**58.2**	**57.7**	41.5	4.7	1.8
1.8	6.6	45.2	**72.7**	**76.6**	**72.4**	43.8	7.3	1.9
2.0	7.9	31.8	**56.8**			31.1	7.7	2.2
2.0	5.8	17.0	30.4			16.9	6.0	2.0
1.9	4.0	9.6	18.4			9.5	4.3	2.0
1.3	3.1	5.5	10.4			5.4	2.9	1.5
1.0	2.1	3.5	5.7			3.6	2.2	1.2
1.5	2.1	2.6	3.5			2.6	2.1	1.4
1.1	1.3	1.4	1.8			1.4	1.3	1.2
1.0	1.1	1.4	1.7			1.4	1.1	0.9

Distance behind bumper (in feet)

1
3
5
7
9
11
13
15
17
19

A total of 907 respondents answered item 22. The number in each box above indicates the percentage of respondents who marked that box.

Q23. Does using the backing aid create any new driving problems or safety concerns for you?

Category	Description	Count	Percentage
1	Yes	30	2.94
2	No	990	97.06
	Subtotal Valid Responses	1,020	100.00
9	Not Ascertained	67	
	Total	1,087	

Q23. If yes, please explain.

Category	Description	Count	Percentage
1	*Perpendicular traffic*	1	3.33
2	*Become too dependent on the aid*	14	46.67
3	*Judging the distance*	1	3.33
94	*Other*	11	36.67
	Subtotal Valid Responses	27	90.00
	Total respondents who responded “yes” to Q23	30	100.00
95	Response did not pertain to the question	2	
96	Text response not reported	1	

Q24. Is there anything about the way that the backing aid system works that you think should be improved?

Category	Description	Count	Percentage
1	Yes	237	24.38
2	No	735	75.62
	Subtotal Valid Responses	972	100.00
8	Don't Know (written on form)	17	
9	Not Ascertained	98	
	Total	1,087	

Q24. If yes, please explain.

Category	Description	Count	Percentage
1	*More audio features*	30	12.66
2	*Front sensors*	20	8.44
3	*Better side range*	32	13.50
4	*Make system easier to use, gauges too small*	2	0.84
5	*Add video features such as TV*	16	6.75
6	*More sensitive, fewer false alarms*	7	2.95
94	*Other*	118	49.79
	Subtotal Valid Responses	225	94.94
	Total respondents who responded “yes” to Q24	237	100.00
95	Response did not pertain to the question	9	
96	Text response not reported	3	

Q25. 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	1,011	73.63
2	No	362	26.37
	Subtotal Valid Responses	1,373	100.00
8	Don't Know (written on form)	51	
9	Not Ascertained	113	
	Total	1,537	

Q25. If you answered no, then what more do you believe could be done?

Category	Description	Count	Percentage
1	*Decrease cost*	2	0.55
2	*Safety features available on all models*	32	8.84
3	*Make safety features standard*	34	9.39
4	*Accommodate different body types*	5	1.38
5	*Design better seatbelts*	4	1.10
6	*Make it easier to enter and exit vehicle*	27	7.46
7	*Larger mirrors*	7	1.93
8	*Camera*	8	2.21
9	*Get rid of blind spots, increase vision*	22	6.08
94	*Other*	137	37.84
	Subtotal Valid Responses	278	76.80
	Total respondents who responded “no” to Q25	362	100.00
95	Response did not pertain to question	36	
96	Text response not reported	48	

APPENDIX C: TABULATED SURVEY RESULTS FOR REAR-VIEW CAMERAS

The following list shows the response frequencies for each item on the rear-view camera 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 5,000 rear-view camera questionnaires mailed out, 1,481 questionnaires were returned within 3 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 Camera	Percentage With Camera
2002	32	2.16	2	0.19
2003	131	8.85	74	6.92
2004	395	26.67	280	26.19
2005	599	40.45	430	40.22
2006	324	21.88	283	26.47
Total	1481	100.00	1,069	100.00

Vehicle manufacturer

Description	Count	Percentage	Count With Camera	Percentage With Camera
Acura	320	21.61	273	25.54
Honda	33	2.23	0	0.00
Infiniti	173	11.68	117	10.94
Land Rover	38	2.57	21	1.96
Lexus	872	58.88	647	60.52
Nissan	37	2.50	11	1.03
Porsche	8	0.54	0	0.00
Total	1,481	100.00	1,069	100.00

Vehicle Models for the Compared Manufacturers

Description	Count With Camera	Percentage of manufacturer
Acura		
MDX	273	100.00
Total	273	100.00
Infiniti		
FX	50	42.74
QX	43	36.75
Q	18	15.38
M	6	5.13
Total	117	100.00
Lexus		
RX	390	57.86
LS	93	13.80
LX	66	9.79
GX	52	7.72
GS	46	6.82
Total	647	95.99

Q1. Age (self-reported)

Description	Count	Percentage	Count with Camera	Percentage with Camera
18 - 34 years	129	8.86	96	9.13
35 - 44 years	294	20.21	222	21.12
45 - 54 years	385	26.46	305	29.02
55 - 64 years	322	22.13	221	21.03
65 - 74 years	204	14.02	139	13.23
75 years or older	121	8.32	68	6.47
Subtotal Valid Responses	1,455	100.00	1051	100.00
Not Ascertained	26		18	
Total	1,481			1069

Q2. Gender

Category	Description	Count	Percentage	Count with Camera	Percentage with Camera
1	Male	761	52.12	556	52.70
2	Female	699	47.88	499	47.30
	Subtotal Valid Responses	1,460	100.00	1,055	100.00
9	Not Ascertained	21		14	
	Total	1,481		1,069	

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

Category	Description	Count	Percentage	Count with Camera	Percentage with Camera
1	Vision problems	51	4.23	26	3.03

2	Hearing problems	9	0.75	7	0.82
3	Difficulty turning my head/neck	38	3.15	26	3.03
4	Other conditions	7	0.58	6	0.70
5	None	1,119	92.86	805	93.93
	Subtotal Valid Responses	1,224		870	
	Total Respondents	1,205	100.00	857	100.00
9	Not Ascertained	259		212	

Q3. Other physical condition (explain).

Category	Description	Count	Percentage	Count with Camera	Percentage with Camera
1	*Physically handicapped*	1	14.29	1	16.67
2	*Physical size*	1	14.29	1	16.67
3	*Joint problems*	2	28.57	1	16.67
94	*Other*	2	28.57	2	33.33
	Subtotal Valid Responses	6		5	
	Total respondents who responded “other” in Q3.	7	100.00	6	100.00
96	Text response not reported	1		1	

Q4. A rear-view video camera shows the driver the area behind the vehicle when you are backing on a screen inside the vehicle. Does your vehicle have a rear-view video camera?

Category	Description	Count	Percentage
1	Yes	1,069	72.18
2	No	412	27.82
	Subtotal Valid Responses	1,481	100.00
9	Not Ascertained	0	
	Total	1,481	

Q4a. If no, then why not?

Category	Description	Count	Percentage
1	It never occurred to me to look for one when I was buying the vehicle.	139	33.74
2	The rear-view camera was not an option on my vehicle.	177	42.96
3	I thought the rear-view camera would be a nuisance or distraction.	25	6.07
4	I wouldn't trust the rear-view camera.	18	4.36
5	I don't need a rear-view camera because I have good backing skills.	37	8.98
6	The rear-view camera was not worth the extra cost.	86	20.87
7	The rear-view camera was only available with other options that I didn't want.	79	19.17

8	I was not the person who purchased or made the decision to purchase this vehicle.	23	5.58
	Subtotal Valid Responses	584	
	Total respondents who responded “no” to Q4	412	100.00
9	Not Ascertained	14	

Q4b. If you purchased this same vehicle again would you want a rear-view camera? (For vehicle owners who do not have a rear-view camera)

Category	Description	Count	Percentage
1	Yes	177	44.58
2	No	90	22.67
8	Don't Know	130	32.75
	Subtotal Valid Responses	397	100.00
9	Not Ascertained	15	
	Total	412	

Q5. If you purchased this same vehicle again would you want a rear-view camera? (For vehicle owners who currently have a rear-view camera system)

Category	Description	Count	Percentage
1	Yes	983	93.18
2	No	22	2.09
8	Don't Know	50	4.74
	Subtotal Valid Responses	1,055	100.00
9	Not Ascertained	14	
	Total	1,069	

Q6. Approximately how many miles have you personally driven this vehicle?

Category	Description	Count	Percentage
	(< 5,000 miles)	156	15.49
	(5,000 to 9,999)	185	18.37
	(10,000 to 19,999)	352	34.96
	(20,000 to 29,999)	173	17.18
	(30,000 to 39,999)	69	6.85
	(40000 to 49,999)	44	4.37
	(>=50,000 miles)	28	2.78
	Subtotal Valid Responses	1,007	100.00
	Don't Know (written on form)	2	
	Not Ascertained	60	
	Total	1,069	

Q7. How did you learn to use your vehicle's rear-view camera?

Category	Description	Count	Percentage
1	Instructions from the dealership, such as video, brochure, or demonstration	602	57.49
2	Vehicle owner's manual	333	31.80
3	Help from a friend or relative	32	3.06
4	Information on the Internet	14	1.34
5	On-road experience and practice (trial and error)	659	62.94
6	I have not yet learned how to use the rear-view camera	9	0.86
	Subtotal Valid Responses	1,649	
	Total Respondents	1,047	100.00
9	Not Ascertained	22	

Q8. Are you aware of any warnings or limitations about your vehicle's rear-view camera?

Category	Description	Count	Percentage
1	Yes	409	39.40
2	No	629	60.60
	Subtotal Valid Responses	1,038	100.00
8	Don't Know (written on form)	1	
9	Not Ascertained	30	
	Total	1,069	

Q8. If yes, please explain.

Category	Description	Count	Percentage
1	*Difficult to judge distance of object*	88	21.51
2	*Glare from sun makes screen difficult to see*	10	2.44
3	*Camera is a tool, but can't be used exclusively*	120	29.33
4	*Visual or spatial distortion*	41	10.02
94	*Other*	74	18.09
	Subtotal Valid Responses	333	81.41
	Total respondents who responded “yes” to Q8	409	100.00
95	Response did not pertain to the question	15	
96	Text response not reported	61	

Q9. How easy was it to learn how to use your vehicle's rear-view camera to judge the distance to objects behind your vehicle?

Category	Description	Count	Percentage
1	Very easy to learn	674	63.89
2	Somewhat easy to learn	290	27.49
3	Somewhat difficult to learn	74	7.01
4	Very difficult to learn	8	0.76
5	I have not tried to learn how to use the rear-view camera	7	0.66
6	I do not want to learn how to use the rear-view camera	2	0.19
	Subtotal Valid Responses	1,055	100.00
9	Not Ascertained	14	
	Total	1,069	

Q10. Were there things that were especially difficult to learn about your vehicle's rear-view camera?

Category	Description	Count	Percentage
1	Yes	98	9.43
2	No	941	90.57
	Subtotal Valid Responses	1,039	100.00
9	Not Ascertained	30	
	Total	1,069	

Q10. If yes, please explain.

Category	Description	Count	Percentage
1	*Judging distance*	56	57.14
2	*Reading the screen*	12	12.24
94	*Other*	28	28.57
	Subtotal Valid Responses	96	97.96
	Total respondents who responded “yes” to Q10	98	100.00
95	Response did not pertain to the question	1	
96	Text response not reported	1	

Q11. In the last two weeks, did you ever use just the camera when backing without checking the mirrors or turning to look out the rear window?

Category	Description	Count	Percentage
1	Yes	182	17.38
2	No	865	82.62
	Subtotal Valid Responses	1,047	100.00
9	Not Ascertained	22	
	Total	1,069	

Q12. Which of the following best describes how much you normally pay attention to the rear-view camera when backing?

Category	Description	Count	Percentage
1	I rarely or never look at it	30	2.88
2	I usually just take a quick glance at the camera screen to determine if I can back up	228	21.88
3	I share my attention about equally between the rear-view camera screen and my mirrors or direct glances out the rear window	703	67.47
4	I pay attention to the rear-view camera screen more than to my mirrors and glances over my shoulder	77	7.39
5	I usually back up the vehicle using only the camera. I don't feel that I need to check mirrors or look out the rear windows	4	0.38
	Subtotal Valid Responses	1,042	100.00
8	Don't Know (written on form)	1	
9	Not Ascertained	26	
	Total	1,069	

Q13. Imagine that your vehicle's rear-view camera broke down. How would your driving behavior change if you could not use your vehicle's rear-view camera anymore?

Category	Description	Count	Percentage
1	I would back up much more slowly	283	26.72
2	I would avoid parking places where I would have to back up	50	4.72
3	I would not try to fit into tight parking spaces	133	12.56
4	I would rely more on my mirrors and/or glances over my shoulder to see what is behind my vehicle	651	61.47
5	My driving behavior would not change	321	30.31
6	Other	31	2.93
	Subtotal Valid Responses	1,469	
	Total Respondents	1,059	100.00
9	Not Ascertained	10	

Q13. Other (specify).

Category	Description	Count	Percentage
1	*Do an external visual check before backing*	9	29.03
94	*Other*	20	64.51
	Subtotal Valid Responses	29	93.55
	Total respondents who responded "other" to Q13	31	100.00
95	Response did not pertain to the question	2	

Q14. If your vehicle's rear-view camera display has lines, graphics, or text information on the screen, do you find these useful?

Category	Description	Count	Percentage
1	My system does not show any other information on the screen, only the rear-view video image	856	82.95
2	Yes, they are useful for…	140	13.57
3	No, they are not useful	36	3.49
	Subtotal Valid Responses	1,032	100.00
9	Not Ascertained	37	
	Total	1,069	

Q14. Yes, they are useful for (explain)

Category	Description	Count	Percentage
1	*Aids in parallel parking*	10	7.14
2	*Helps determine distance of the object*	63	45.00
94	*Other*	48	34.29
	Subtotal Valid Responses	121	86.43
	Total respondents who responded “yes” to Q14	140	100.00
95	Response did not pertain to the question	3	
96	Text response not reported	16	

Q14. No, they are not useful (explain)

Category	Description	Count	Percentage
1	*Helpful to have a beeping sound to indicate*	3	8.33
94	*Other*	20	55.55
	Subtotal Valid Responses	23	63.88
	Total respondents who responded “no” to Q14	36	100.00
95	Response did not pertain to the question	5	
96	Text response not reported	8	

Q15. How well does your vehicle's rear-view camera work in the following weather conditions?

Q15a. Darkness

Category	Description	Count	Percentage
1	Not At All	7	0.67
2	Poorly	89	8.54
3	Fairly Well	480	46.07
4	Perfectly	398	38.20
8	Don't Know	68	6.53
	Subtotal Valid Responses	1,042	100.00
9	Not Ascertained	27	
	Total	1,069	

Q15b. Fog

Category	Description	Count	Percentage
1	Not At All	7	0.68
2	Poorly	59	5.70
3	Fairly Well	258	24.93
4	Perfectly	184	17.78
8	Don't Know	527	50.92
	Subtotal Valid Responses	1,035	100.00
9	Not Ascertained	34	
	Total	1,069	

Q15c. Cold temperatures

Category	Description	Count	Percentage
1	Not At All	0	0.00
2	Poorly	5	0.48
3	Fairly Well	213	20.50
4	Perfectly	520	50.05
8	Don't Know	301	28.97
	Subtotal Valid Responses	1,039	100.00
9	Not Ascertained	30	
	Total	1,069	

Q15d. Rain

Category	Description	Count	Percentage
1	Not At All	0	0.00
2	Poorly	52	5.01
3	Fairly Well	464	44.74
4	Perfectly	392	37.80
8	Don't Know	129	12.44
	Subtotal Valid Responses	1,037	100.00
9	Not Ascertained	32	
	Total	1,069	

Q15e. Snow

Category	Description	Count	Percentage
1	Not At All	1	0.10
2	Poorly	18	1.77
3	Fairly Well	114	11.22
4	Perfectly	123	12.11
8	Don't Know	760	74.80
	Subtotal Valid Responses	1,016	100.00
9	Not Ascertained	53	
	Total	1,069	

Q15f. Bright sun

Category	Description	Count	Percentage
1	Not At All	14	1.34
2	Poorly	93	8.93
3	Fairly Well	311	29.85
4	Perfectly	595	57.10
8	Don't Know	29	2.78
	Subtotal Valid Responses	1,042	100.00
9	Not Ascertained	27	
	Total	1,069	

Q15. Are there any other conditions where your rear-view camera does not work well?

Category	Description	Count	Percentage
1	*Changing from light to dark or dark to light*	45	50.00
2	*False readings (including mud on camera lens)*	17	18.89
94	*Other*	22	24.44
	Subtotal Valid Responses	84	93.33
	Total Respondents	90	100.00
95	Response did not pertain to the question	6	

Q16. Overall, how easy is the rear-view camera to use when backing out of a driveway?

Category	Description	Count	Percentage
1	Very easy to use	831	78.99
2	Somewhat easy to use	178	16.92
3	Somewhat difficult to use	27	2.57
4	Very difficult to use	5	0.48
8	Don't know	11	1.05
	Subtotal Valid Responses	1,052	100.00
9	Not Ascertained	17	
	Total	1,069	

Q17. How has your usage of the rear-view camera changed since you first got the vehicle?

Category	Description	Count	Percentage
1	I use it more now than I did in the beginning.	421	40.40
2	I use it less now than I did in the beginning.	30	2.88
3	My usage has stayed about the same.	591	56.72
	Subtotal Valid Responses	1,042	100.00
9	Not Ascertained	27	
	Total	1,069	

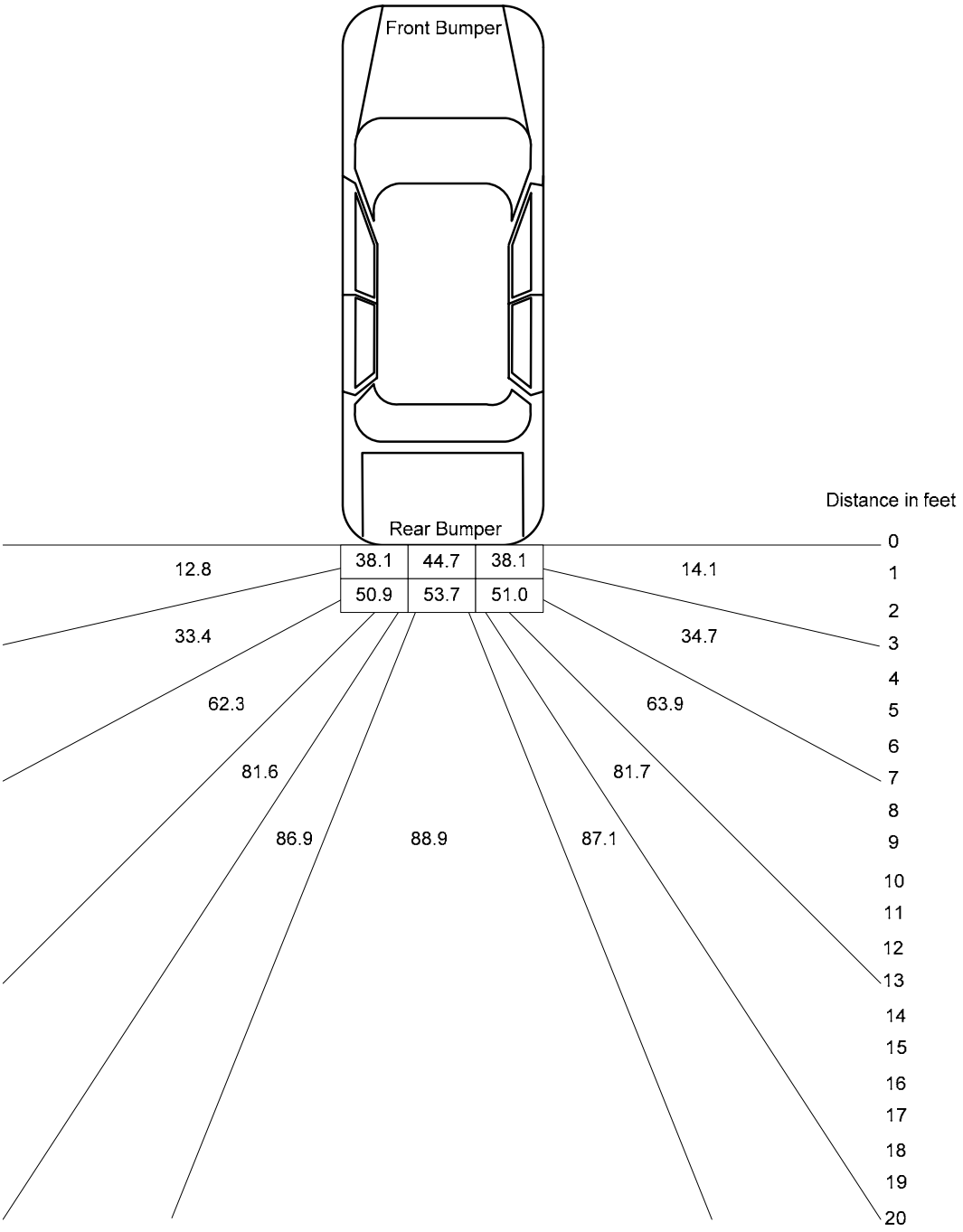
Q17. I use it more now than I did in the beginning, why?

Category	Description	Count	Percentage
1	*Dependable*	16	3.80
2	*Confident in the system*	161	38.24
3	*Gives additional help in backing*	34	8.08
94	*Other*	31	7.36
	Subtotal Valid Responses	242	57.48
	Total respondents who responded “more” to Q17	421	100.00
95	Response did not pertain to the question	2	
96	Text response not reported	177	

Q17. I use it less now than I did in the beginning, why?

Category	Description	Count	Percentage
1	*Don't feel it's reliable*	6	20.00
2	*Distracting*	3	10.00
94	*Other*	5	16.67
	Subtotal Valid Responses	14	46.67
	Total respondents who responded “less” to Q17	30	100.00
95	Response did not pertain to the question	0	
96	Text response not reported	16	

Q18. Suppose that the diagram below shows an overhead view of your vehicle and areas labeled “A” – “Q”. Based on your experience, please circle the letters for <u>all areas where your rear-view camera would show you obstacles</u> such as a small child sitting on the ground.



A total of 953 respondents answered item Q18. The number in each area above indicates the percentage of respondents who marked that area.

Q19. Please indicate how much you agree or disagree with each of the following statements.

Q19a. The rear-view camera screen is in a location where it is easy to see when I am backing.

Category	Description	Count	Percentage
1	Strongly Disagree	9	0.87
2	Disagree	12	1.16
3	Neutral	51	4.94
4	Agree	432	41.86
5	Strongly Agree	528	51.16
	Subtotal Valid Responses	1,032	100.00
9	Not Ascertained	37	
	Total	1,069	

Q19b. I am more confident in my backing abilities when I use the rear-view camera.

Category	Description	Count	Percentage
1	Strongly Disagree	17	1.65
2	Disagree	43	4.17
3	Neutral	153	14.83
4	Agree	389	37.69
5	Strongly Agree	430	41.67
	Subtotal Valid Responses	1,032	100.00
9	Not Ascertained	37	
	Total	1,069	

Q19c. I am more willing to park in small or difficult parking spaces when I use the rear-view camera.

Category	Description	Count	Percentage
1	Strongly Disagree	58	5.65
2	Disagree	141	13.73
3	Neutral	309	30.09
4	Agree	245	23.86
5	Strongly Agree	274	26.68
	Subtotal Valid Responses	1,027	100.00
9	Not Ascertained	42	
	Total	1,069	

Q19d. It's easy to tell how close I am to an obstacle by looking at the rear-view camera display.

Category	Description	Count	Percentage
1	Strongly Disagree	37	3.59
2	Disagree	144	13.97
3	Neutral	208	20.17
4	Agree	358	34.72
5	Strongly Agree	284	27.55
	Subtotal Valid Responses	1,031	100.00
9	Not Ascertained	38	
	Total	1,069	

Q19e. The rear-view camera does not show the entire area behind the vehicle. That I need to see when backing, in other words, there is a blind spot.

Category	Description	Count	Percentage
1	Strongly Disagree	115	11.25
2	Disagree	274	26.81
3	Neutral	264	25.83
4	Agree	275	26.91
5	Strongly Agree	94	9.20
	Subtotal Valid Responses	1,022	100.00
9	Not Ascertained	47	
	Total	1,069	

Q19f. The rear-view camera display gets blurry or hard to see if I am moving.

Category	Description	Count	Percentage
1	Strongly Disagree	339	33.04
2	Disagree	535	52.14
3	Neutral	123	11.99
4	Agree	18	1.75
5	Strongly Agree	11	1.07
	Subtotal Valid Responses	1,026	100.00
9	Not Ascertained	9	
	Total	1,035	

Q19g. The rear-view camera gets dirty and makes obstacles hard to see.

Category	Description	Count	Percentage
1	Strongly Disagree	289	28.09
2	Disagree	527	51.21
3	Neutral	153	14.87
4	Agree	46	4.47
5	Strongly Agree	14	1.36
	Subtotal Valid Responses	1,029	100.00
9	Not Ascertained	40	
	Total	1,069	

Q19h. Sun glare on the video display makes it hard for me to see objects or people.

Category	Description	Count	Percentage
1	Strongly Disagree	171	16.80
2	Disagree	375	36.84
3	Neutral	200	19.65
4	Agree	196	19.25
5	Strongly Agree	76	7.47
	Subtotal Valid Responses	1,018	100.00
9	Not Ascertained	51	
	Total	1,069	

Q19i. It's hard to distinguish something or someone who may be in a shadow area behind my vehicle (Image contrast level is poor in camera).

Category	Description	Count	Percentage
1	Strongly Disagree	225	22.21
2	Disagree	439	43.34
3	Neutral	253	24.98
4	Agree	79	7.80
5	Strongly Agree	17	1.68
	Subtotal Valid Responses	1,013	100.00
8	Don't Know (written on form)	1	
9	Not Ascertained	55	
	Total	1,069	

Q19j. My risk of hitting somebody while backing is lower with the rear-view camera than without it.

Category	Description	Count	Percentage
1	Strongly Disagree	19	1.84
2	Disagree	37	3.59
3	Neutral	82	7.96
4	Agree	372	36.12
5	Strongly Agree	520	50.49
	Subtotal Valid Responses	1,030	100.00
9	Not Ascertained	39	
	Total	1,069	

Q20. Have you ever unintentionally backed into something or had a "close call" since you started driving this vehicle?

Category	Description	Count	Percentage
1	Yes	145	14.11
2	No	883	85.89
	Subtotal Valid Responses	1,028	100.00
9	Not Ascertained	41	
	Total	1,069	

Q20. If yes, were you using the camera at the time? Please describe the situation.

Category	Description	Count	Percentage
1	*Stationary object*	45	31.03
2	*Moving object*	13	8.97
3	*Pedestrian*	7	4.83
4	*Side of car*	10	6.90
5	*Blind spot*	3	2.07
6	*Camera prevented accident*	4	2.76
94	*Other*	27	18.62
	Subtotal Valid Responses	109	75.17
	Number of respondents who responded “yes” to Q20	145	100.00
95	Response did not pertain to the question	18	
96	Text response not reported	18	

Q21. Does using the rear-view camera create any new driving problems or safety concerns for you?

Category	Description	Count	Percentage
1	Yes	74	7.21
2	No	952	92.79
	Subtotal Valid Responses	1,026	100.00
9	Not Ascertained	43	
	Total	1,069	

Q21. If yes, please explain.

Category	Description	Count	Percentage
1	*Perpendicular traffic*	2	2.70
2	*Become too dependent on the camera*	25	33.78
3	*Judging distance*	6	8.11
94	*Other*	28	37.84
	Subtotal Valid Responses	61	82.43
	Number of respondents who responded “yes” to Q21.	74	100.00
95	Response did not pertain to the question	7	
96	Text response not reported	7	

Q22. Overall, does having the rear-view camera make you a safer driver?

Category	Description	Count	Percentage
1	Safer	792	77.12
2	Neither more nor less safe	232	22.59
3	Less safe	3	0.29
	Subtotal Valid Responses	1,027	100.00
9	Not Ascertained	42	
	Total	1,069	

Q23. Is there anything about the rear-view camera that you think should be improved?

Category	Description	Count	Percentage
1	Yes	443	46.10
2	No	518	53.90
	Subtotal Valid Responses	961	100.00
8	Don't Know (written on form)	3	
9	Not Ascertained	105	
	Total	1,069	

Q23. If yes, please explain.

Category	Description	Count	Percentage
1	*Audio features*	45	10.16
2	*View larger area*	110	24.83
3	*Distance to object*	76	17.16
4	*Improve quality of picture*	102	23.02
5	*Display screen should be in rear of vehicle*	3	0.68
94	*Other*	100	22.57
	Subtotal Valid Responses	436	98.42
	Total respondents who responded “yes” to Q23	443	100.00
95	Response did not pertain to the question	5	
96	Text response not reported	11	

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

Category	Description	Count	Percentage
1	Yes	982	75.19
2	No	324	24.81
	Subtotal Valid Responses	1,306	100.00
8	Don't Know (written on form)	51	
9	Not Ascertained	124	
	Total	1481	

Q24. If you answered no then what more do you believe could be done?

Category	Description	Count	Percentage
1	*Decrease cost*	8	2.47
2	*Safety features available on all models*	20	6.17
3	*Make safety features standard*	22	6.79
4	*Enlarge text on display and/or device*	17	5.24
5	*Make it easier to enter and exit vehicle*	20	6.17
6	*Larger mirrors*	11	3.40
7	*Get rid of blind spots, increase vision*	19	5.86
94	*Other*	113	34.88
	Subtotal Valid Responses	230	70.99
	Total respondents who responded “no” to Q24	324	100.00
95	Response did not pertain to the question	32	
	Total	70	

APPENDIX D: DISCUSSION GUIDE FOR TELEPHONE INTERVIEWS WITH OWNERS OF BACKING AID SYSTEMS AND REAR-VIEW CAMERAS

Rear-View Video Camera and Backing Aid System

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 (Rear-view camera / Backing aid system) 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 (Rear-view camera / Backing aid system) 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 (Rear-view camera / Backing aid system) was particularly helpful or caused a problem.

Have you changed your driving habits as a result of the (Rear-view camera / Backing aid system)? 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 E: COMMENTS FROM TELEPHONE INTERVIEWEES WHO OWN SENSOR-BASED BACKING AID SYSTEMS

ID #	Age	Gender	Backing aid system (BAS) improvements needed?	Is the technology helpful or hurtful?	Changes in driving habits?	Vehicle manufacturers doing enough for needs of older people?	Other concerns?
521	83	M	There is some delay in activating. Seems to have more side sensitivity and less distance sensitivity. Possible that a too-low target wouldn't be picked up. For tight-spot backing, it is good.	No comment	No	Older Cadillac he's owned had auto dimming headlights. Indicated it would be nice if that feature would work on cars behind you, so their headlights would dim as they get closer to your vehicle - not just auto dim when other approaching headlights are detected.	
2812	81	M	Distance is OK. Sensitivity is bad for a low object. A railing off to the side is not easily detected either.	Helpful – feels more secure. Backs up slowly now, but still uses his mirrors.	No	Seats on swivels would be helpful, as husband has a bad left leg – hard to lift his leg.	

ID #	Age	Gender	Backing aid system (BAS) improvements needed?	Is the technology helpful or hurtful?	Changes in driving habits?	Vehicle manufacturers doing enough for needs of older people?	Other concerns?
1559	69	F	Toyota Sienna camera lens gets dirty easily, worse in the rain. When van is put in reverse, RVV screen is blocked by text to turn audio on/off. Displays some info not related to backing.	Love it – it's another piece of information. With 2 people in the front seat, one checks the mirrors and the other checks the video screen. Nicknamed the van "Toyota Rose"	No change in driving habits. But, it is one more piece of safety information - "Getting some assistance from technology that is helping me."	Recommends more hand holds. She has used her roof rack as a hand hold to get in/out of the van. Her dad's comments: "I use two hands and one foot, like a tripod; that way I have good balance and won't fall." She said older people tend not to look over their shoulders when they change lanes; they also don't look for themselves as being in someone's blind spot. It would be a good idea if turn signal would activate a camera showing the blind spots.	The NAV system on her vehicle at one time kept telling her to get off the freeway at every off ramp. She later found it had an option to turn off "select surface streets only." She also has adaptive cruise control on her vehicle. Her last comment was "Finally, a man who listens!"

ID #	Age	Gender	Backing aid system (BAS) improvements needed?	Is the technology helpful or hurtful?	Changes in driving habits?	Vehicle manufacturers doing enough for needs of older people?	Other concerns?
3825	80	M	Toyota Sienna – has RVV. Picture is great, but "Audio is On" text appears on screen at first. You have to back up 10 feet before it goes off. Camera is great at night in a dark area though. But if a child is under the car bumper when you start to back up, it will not show this.	No specific example.	No – but system has taught him to not back up quickly.		Vehicle has 3 or 4 sensors, front and rear. If you are too close to something while you are driving, it tells you by beeping.
369	77	M	Sound could be louder.	No problem but needs to be louder for him.	No change in driving habit, but the device is safer for the car in particular – it keeps you from getting it "dinged up."	N/A	He has a Lexus 430 as well as this Jaguar S. It can be confusing telling the difference in distance in detecting and alerting you of something, when comparing the two cars.

ID #	Age	Gender	Backing aid system (BAS) improvements needed?	Is the technology helpful or hurtful?	Changes in driving habits?	Vehicle manufacturers doing enough for needs of older people?	Other concerns?
4170	80	M	Toyota Sienna has BAS but not RVV. He didn't know some vehicles have a RVV and thought it would be good for some vehicles.	No problem, but very helpful – when you are two feet away, it will beep.	No change.	Glare on windshield from sunlight is distracting. Instrument displays for ACC is behind a polarized screen. When he's wearing polarized sunglasses, this display goes completely black and he can't see the speed setting for the ACC.	
2047	80	M	Unit needs more sensitivity so range is better behind vehicle.	No problem.	No change in driving habit; however, they have purchased a new car since the survey was filled out. Their positive experience with 2003 Lincoln (survey vehicle) prompted them to seek that feature in their new vehicle.	Seats or headrests in vehicle restrict view out the back when using the inside mirror.	
2862	80	F	BAS only has lights in mirror – there is no sound, which would be nice. Also, lights are inoperative at the time; will go back to the dealer to have them fixed.	Only problem is that lights are not working right now, making backing up more difficult.	No change, but noted that the Lincoln she has (other vehicle) is easier to drive – power steering is easier to turn than this (survey) vehicle – Chrysler Town&Country. Steering for T&C is difficult. Chrysler did pay for a lift device to	It would be nice if a similar device to BAS existed in the front of the vehicle to let them know how close they were to another car's bumper or a wall.	

ID #	Age	Gender	Backing aid system (BAS) improvements needed?	Is the technology helpful or hurtful?	Changes in driving habits?	Vehicle manufacturers doing enough for needs of older people?	Other concerns?
					put her scooter in the vehicle, but they had to give up a seat position to have the device installed.		
398	47	M	Recommend the BAS device actually apply the brakes and stop the car when you are too close to something.	No problems – very helpful.	Yes – definitely changed driving habits. He's very cautious now. It is easy to confuse a car with the device, expecting it to beep at you when you are close, and then it doesn't beep.	N/A	
2437	79	M	Lateral detection needs improvement. Distance front to rear is OK, as long as you are going slowly.	No problems - very helpful. He relies on it. Also has a 2000 Mercedes without this system. He feels more comfortable backing up with the Expedition (survey vehicle) than he does when he's in the Mercedes.	Yes - he's more cautious since he knows its limitations - immediately apparent.	N/A	

ID #	Age	Gender	Backing aid system (BAS) improvements needed?	Is the technology helpful or hurtful?	Changes in driving habits?	Vehicle manufacturers doing enough for needs of older people?	Other concerns?
4076	80	M	Differentiate the sound for left side, right side, rear, and front.	No problems.	No change.	N/A	Recently he remodeled his garage and put in a 4" high bumper so he can run front tires up against that. Then he knows he's far enough inside garage for garage door to close. For him, it would be helpful to have a different sound or tone frequency to let him know what side he is too close on, or when something is in a particular location (left rear, for example).
2974	57	M	Mercury Mountaineer – BAS has sounds only. RVV was not an option for that year, but it is for current year model.	No problem – great help in parking. People are constantly walking behind your vehicle when you are trying to get out of a parking spot. They are not paying attention to your car.	No change. However, he did put a RVV in his other vehicle – GMC Sierra pickup – but the image is too bouncy. A beeper would be better. The truck has the camera only, but he wants to put a beeper in it.	Keyless entry code would be great – if an older person (or anyone) cannot remember the code, they are probably not in a good enough frame of mind or may not be cognizant enough to drive safely.	

ID #	Age	Gender	Backing aid system (BAS) improvements needed?	Is the technology helpful or hurtful?	Changes in driving habits?	Vehicle manufacturers doing enough for needs of older people?	Other concerns?
3883	60	M	System would be improved with visual cues – Jaguar has proximity alarm (sounds) only.	No problem – helpful though, as he has learned how to get used to it. His wife's car doesn't have it, but visual cues would be helpful in differentiating the two vehicles.	No change.	N/A	
4201	75	M	Chrysler Town&Country – basically has no lateral coverage. Distance straight back is OK if you are not going too quickly.	No problem – very helpful though in backing into a parking stall. Never has been a problem.	No change, other than since he is older, he is much more cautious, especially with Southern California drivers.	N/A	

ID #	Age	Gender	Backing aid system (BAS) improvements needed?	Is the technology helpful or hurtful?	Changes in driving habits?	Vehicle manufacturers doing enough for needs of older people?	Other concerns?
4272	45	M	Ford Excursion - has a switch to turn BAS off, but each time you put trans back into Drive, BAS goes back on again. This is a nuisance when backing a trailer into a tight spot where you have to jockey the trailer around, forward and reverse, etc. Would be nice if "Off" switch would stay off until he wanted it back on again.	Very helpful normally, no real problem other than with trailer backing.	No change in driving habits, but he no longer has the Excursion. His new GMC Sierra doesn't have it, and he misses that feature.	N/A	

ID #	Age	Gender	Backing aid system (BAS) improvements needed?	Is the technology helpful or hurtful?	Changes in driving habits?	Vehicle manufacturers doing enough for needs of older people?	Other concerns?
226	68	M	Vehicle has both lights and sounds. A similar system for the front would be a help.	Very helpful in a parking lot at night (i.e., in the dark when leaving a crowded area like a sports arena, etc.) where people are constantly walking behind your vehicle. The device is sensitive enough to pick up a small pole in a parking lot, directly behind the vehicle. His second vehicle also has a similar system. That vehicle is parked in a garage with a fence going alongside the garage on that side. That device beeps constantly until he is past the fence.	No change.	N/A	

ID #	Age	Gender	Backing aid system (BAS) improvements needed?	Is the technology helpful or hurtful?	Changes in driving habits?	Vehicle manufacturers doing enough for needs of older people?	Other concerns?
1645	57	M	Vehicle has lights and sounds. System did not light up or sound while backing up and a second vehicle backing up at a 45-degree angle collided with his car.	System was not helpful - had a minor bump while backing up. He could not even see the other vehicle at all visually through mirrors or windows, and it was not detected by the device either.	Yes – he drives slowly while backing up and looks all around his vehicle before getting into it since he has had two minor fender benders; but says he still can be surprised.	N/A	

ID #	Age	Gender	Backing aid system (BAS) improvements needed?	Is the technology helpful or hurtful?	Changes in driving habits?	Vehicle manufacturers doing enough for needs of older people?	Other concerns?
3327	43	M	Has a Lincoln Navigator now; previously had a 2004 Lincoln Aviator which also had a BAS. First of two Chrysler 300C Hemis did not have it (last year). This year's 300C has both sound and lights. On this 300C, the location of the yellow/red lights is up high, not at eye level. It would help if it beeped when you first put the transmission in Reverse to let you know the system is active, and that you are in a car with this type of device.	Most helpful in parallel parking. The bad thing is that you tend to get complacent and feel it will "save your life." Gives you a false sense of security or thinking it will beep when in fact you are in a car without the device installed. One of his clients had a Lincoln Blackwood with the system. He sold or traded the vehicle for a Chevy Avalanche without the system. He backed into his girlfriend's car accidentally.	No real change in driving habits, but he needs to be aware of what vehicle he is driving – does it have this system or not?	Even though he's only 43, he noted that cars are getting "too techie" – on gadgets, etc., it is hard to change some controls/settings (e.g.. clock buttons) because the set button or dial is too small. His parents would have a hard time using some of the things on this Chrysler 300C Hemi he has now.	Side comment – on vehicles with RVV, you usually look down to the center console. This seems odd. You should be looking out the back window.
2663	44	M	There is no switch to shut it off – would be a nice feature to disable it when he has bikes on the hitch mount.	No problem. Very handy for parallel parking. For small objects, it is fine.	No change in driving habits. However, he is more willing to try parking in a tighter parking place now with this device.	N/A	He has a portable NAV system (legal type), and this gives him a heads-up display. He finds this very helpful as opposed to a built-in (in-dash) display

ID #	Age	Gender	Backing aid system (BAS) improvements needed?	Is the technology helpful or hurtful?	Changes in driving habits?	Vehicle manufacturers doing enough for needs of older people?	Other concerns?
							Where you have to take your eyes off the road to use it.
2796	75	M	System uses the same bell as the seat belt. It would be nice for another tone; it also needs to be louder! If three or four people are in the car, or the radio is on, it is hard to hear it.	Helpful – he uses all three mirrors because he knows it's there but it is limited – it doesn't give enough warning time for quicker-moving vehicles as they approach from the side.	No change.	Jaguar shares the same platform as the Taurus - the windshield angle and glare from the sun is bad. The read rest size (back seat) restricts rearward vision through the center mirror.	

ID #	Age	Gender	Backing aid system (BAS) improvements needed?	Is the technology helpful or hurtful?	Changes in driving habits?	Vehicle manufacturers doing enough for needs of older people?	Other concerns?
1925	74	M	System is not ground level sensitive. It could be made more sensitive to detect curbs, etc.	Very helpful in avoiding trash cans. He did not see them when backing up, and is not sure when they were put there, but the device alerted him of their presence.	Yes – when backing now he stops farther away (as soon as he hears the sounds) than he did with other vehicles that he could see through the back window better. He started doing this as soon as he got the car, since visually he can't see out the back window by turning around (he doesn't rely on his mirrors). Headrests are in the way, and he has a small view through the rear window itself. He's a real estate broker, and usually has Cadillac deVilles as they have better rear view for him.	Side view mirrors aren't much help in backing up. Headrests interfere with rear view and generally it is just harder to see out the back to see where the back end of the car is, and how close you are to something.	

ID #	Age	Gender	Backing aid system (BAS) improvements needed?	Is the technology helpful or hurtful?	Changes in driving habits?	Vehicle manufacturers doing enough for needs of older people?	Other concerns?
1138	80	M	He says he does not have any backing aid system on his Chevy van. He had wanted to put a RVV system in it (aftermarket), but the price was $450 plus $200 installation, so he declined. Some of his survey responses seem to indicate he has a BAS though.	N/A	N/A	N/A	
3213	76	M	His BAS had no sound when he took the vehicle in for servicing previously, but now it has sound, so it must have been repaired. His system has lights above the rear window – one yellow, and two red lights. When you are within one foot, the system lets you know with all the lights lit.	No problems – Vehicle has four sensors on back, and beeps on getting close to garage door.	Yes – he is getting to rely on it more than he feels he should. Technology tends to do that. How soon? Right away.	He put a RVV camera on his motorhome. At night, with a backup light and RVV, it's incredible! During the day with sunlight though, the RVV gets washed out and is basically useless. One thing he added to his car was a turn signal flasher on the side mirror (mid-car turn indicator). He feels this is useful to let people on the side of you know you are intending to change into the lane – it also lets you know your turn signal is still on.	

ID #	Age	Gender	Backing aid system (BAS) improvements needed?	Is the technology helpful or hurtful?	Changes in driving habits?	Vehicle manufacturers doing enough for needs of older people?	Other concerns?
4055	77	M	Needs to be a wider field. There is really no side notification.	No problem. Always helpful if it's making a noise.	No change – says he's too old to change at 78.	Suggest there be a sensor on each of the four corners, with a different tone or a way to tell what area of the car is being affected. He said it's very important to keep your foot on the brake when backing out of an area where you can't see the side.	
5012	84	M	Barely the width of the car on the side is detected. In a parking lot backing up, it can't detect the sides, or perhaps a vehicle directly behind you who is also backing up quickly. Vehicle has two sensors on the back, some have four. He feels the sensors should be spaced out farther apart, and five to six degrees directed outwardly; this would help.	Helpful – the device is there as an assistant; it gives additional input to your own senses and abilities.	No real change in driving habits.	He was raised in British Columbia, and they used to have categories for drivers there. The police could stop you at any time, get in your car with the device(s) to test your reaction time, vision, etc. You would be graded on your abilities as tested at that time, and given a driver's license accordingly.	

ID #	Age	Gender	Backing aid system (BAS) improvements needed?	Is the technology helpful or hurtful?	Changes in driving habits?	Vehicle manufacturers doing enough for needs of older people?	Other concerns?
2092	36	F	Spoke to husband. BAS has sound and lights. Visual alerts are small in the rear view mirror, and hard to see. Also, at night, the third brake light glare in the rear window makes it hard to see the visual alerts of the BAS.	Lots of times it is helpful. One issue he has with it is the slant of his driveway when backing up – the device picks up the vertical distance difference and sounds off when there is actually no danger there.	Yes – he relies on the device in the van (survey vehicle) more, and pays less attention to other visual inputs than he does when he's driving his own car (Malibu – non-equipped). Time frame? Almost immediately he began to rely on the device in the van.	N/A	
4181	68	M	No longer has vehicle – has a M-B R500 now. Feels the Cadillac (survey vehicle) would have been improved if it had the identical system to the M-B (lights and sounds) in the front to help in parallel parking.	Very helpful with backing up. Short posts, people, and shopping carts are detected. People are forever walking in back of you when you are trying to back up.	Yes – the only change in his driving habits was the system's lights telling you when to stop. He learned that right away.	N/A	

ID #	Age	Gender	Backing aid system (BAS) improvements needed?	Is the technology helpful or hurtful?	Changes in driving habits?	Vehicle manufacturers doing enough for needs of older people?	Other concerns?
3580	69	M	Buick Rendezvous (sold in 2005). Has lights in the rear for the BAS, above the 3rd-row seat, in an inset which is hard to see. He hears the beep, but there is no visual warning on the dashboard; feels lights should be on the dashboard.	Helpful – the audible part was OK. The Hyundai Santa Fe he now has does not even have this as an option. He would have purchased a BAS if it had been an option on the Santa Fe. He had one put in his F-250 for which he traded the Rendezvous. However, the one put into the F-250 was put into the trailer hitch receiver – bad idea.	Yes – it made him more alert. Before, he only had visual warnings. It was a gradual learning curve, took about two weeks for him to get used to it.	In response to his six comments on this question: 1. Auto darkening/lightening windows like auto rear-view mirrors would be nice. Tinted windows do not help at night, particularly for older drivers. 2. Bluetooth capability should be on all cars, as well as On-Star. On-Star was one of the main features why the Rendezvous was purchased. 3. Many handles are hidden – you have to reach under the dash for brake release. It was better when there was a brake release handle between the seats, like old VWs. 4.F-250 has large wide-view mirrors. He sought one for Santa Fe because he knew its value – they have saved him from a number of accidents. 5. HID-equipped vehicles on a road with dips and curves. When the light first gets to your eyes, it is blinding. Regular lights should be auto-dimming on all cars.	

ID #	Age	Gender	Backing aid system (BAS) improvements needed?	Is the technology helpful or hurtful?	Changes in driving habits?	Vehicle manufacturers doing enough for needs of older people?	Other concerns?
						6.Better fuel economy – everyone wants this. One problem is people seem to want "faster" all the time, in lieu of better economy.	

ID #	Age	Gender	Backing aid system (BAS) improvements needed?	Is the technology helpful or hurtful?	Changes in driving habits?	Vehicle manufacturers doing enough for needs of older people?	Other concerns?
4471	78	M	Lincoln Town Car – Vehicle has tone only, no lights. A RVV would be a big help as it would provide extra input.	No problems, but very helpful in parking lots.	No change in driving habits.	Greater angle on sensitivity out to the left and right would be helpful to give more reaction time, or when someone darts out behind you. Swivel seats would greatly improve ease of getting in and out.	
2535	50	F	BMW 750 – system is not sensitive enough to pick up low curbs (parking lot bumpers) or a dog.	Helpful in making wide turns into tight parking spots.	Yes. It makes you very alert. However, system also has forward sensors that let you know if you are too close, or someone else gets too close to you. This can be scary on the freeway. It alerts you when the car next to you gets too close. It was a very short time for her to learn this characteristic.	Vehicle she has now has plenty/good cup holders, but most cars don't. Says it used to be no one got into a car with a drink. Now everyone has a drink/cup of something with them when they go anywhere. E.g.., her husband always has a Snapple with him. He had an accident, got out of vehicle, and took Snapple with him. Other people though he had alcohol!	
4961	87	M	He has noticed a couple of false readings – something sets it off. Could help if side detection were added or improved thereon.	"Fabulous device." It's better to have a "false positive" than a "false negative."	Yes. It taught him to hit the brakes or slow down. He learned this immediately.	Seat adjustability – he's 87, and the seat memory on his Jaguar doesn't work now. When he is making a left hand turn, the "A" pillar restricts his vision because it's extra wide at the base. It is harder as you get older to get up out of a lower car than when you are	

ID #	Age	Gender	Backing aid system (BAS) improvements needed?	Is the technology helpful or hurtful?	Changes in driving habits?	Vehicle manufacturers doing enough for needs of older people?	Other concerns?
						younger.	
1061	51	F	Lincoln Aviator – Camera was not available. Maybe if she was a lot older or needed thick glasses, a camera would have been nice.	No problems. It was very helpful when one grandchild she didn't see was behind the car and she was glad the system alerted her.	Yes – it made her look more closely. It picks up things you would not normally see, like parking curbs, even changing from a cement area to grass. It took her a couple of days to adapt to it. The first time backing out of her parking structure (covered patio), she thought it was a great feature to have.	A camera would take you away from just looking, because you are actually spending time looking at that, instead of paying attention and looking through the windows. Her system has sounds only, and for her it is a great feature.	
1627	84	F	Lincoln Town Car – needs more side range; 180 degrees would be great.	Very helpful in parking lots with people pushing shopping carts. They miss having BAS and using it on the van they have,	BAS has sounds only, no lights. Yes, changed driving habits immediately, and it improved their driving habits.	All cars should have BAS and adaptive headlights. Cars should be designed so there are no blind spots – better side view mirrors. She's 84, driving since she was 14 with no wrecks.	

ID #	Age	Gender	Backing aid system (BAS) improvements needed?	Is the technology helpful or hurtful?	Changes in driving habits?	Vehicle manufacturers doing enough for needs of older people?	Other concerns?
1898	65	M	Will detect smaller items, like a tricycle, but you need to be on top of it before it will detect it.	Never a problem. Wife's Cadillac has greater sensitivity than his 2005 Cadillac (survey vehicle). Her car is lower than his.	No change in driving habits.	Cars are too sophisticated. Should be more intuitive (e.g., NAV system – his car and four other friends have it). He's the only one of the four who uses it – it has too much "detailed" information that's not needed just for a navigation system that just needs to give you directions to an address. It doesn't need all the toilet stops along the way. He used the DVD/CD that came with his NAV system to learn it, but said it has a lot of steps you need to go through before you actually "learn" it.	

ID #	Age	Gender	Backing aid system (BAS) improvements needed?	Is the technology helpful or hurtful?	Changes in driving habits?	Vehicle manufacturers doing enough for needs of older people?	Other concerns?
679	68	M	Better range is needed for side assistance.	Always helpful, never a problem, as long as you back up slowly.	Yes – he pulled up (backing up) too quickly to an adult community security gate and ran into a sign post. He heard the sound and by the time he could react, he ran into the post. It cost him $600 to repair the car, plus $200 for the sign and post. After that, he's much slower in backing up.	An add-on device for his Highland SUV has lights with a license plate frame type system – says it is not nearly as sensitive. It is basically no good for side help. All SUVs should have cameras, because you just cannot see how close you are to the back, or have any feel for who's approaching on the side(s). Also, our survey does not ask if the BAS is factory OEM or an add-on system. (NOTE: the NAV survey does ask this).	
5376	36	F	No longer have the Jaguar (survey vehicle). Now have a 2007 truck and a 2006 M-B. Says beeps should come more quickly (at an increasingly faster rate than they do) as you get closer.	Helpful all around the car. Her husband did not like the forward sensors as he tends to tailgate other vehicles.	Yes, you become too dependent on it. On a car without it, you lose your sense of distance. It took a few months to get used to it. On the Jaguar, the sound would go off early - you had ample warning, actually more than enough room. She got out of her vehicle a number of times after it first started beeping, and saw she had plenty of room to go before	Disappointed in a getting a 2006 M-B for $100,000 and finding it did not have any sensors.	

ID #	Age	Gender	Backing aid system (BAS) improvements needed?	Is the technology helpful or hurtful?	Changes in driving habits?	Vehicle manufacturers doing enough for needs of older people?	Other concerns?
					she got very close to other objects.		
396	68	M	Would help if vehicle had an externally audible beep or warning when backup up, like trash trucks have.	No problem, but the camera went out. Cost him $1,000 to have it fixed. Vehicle has no audible sound on backup.	No change in driving habits at all. He likes it as being an aid, especially in parking lots like Costco's. Toyota also sent out a survey after the camera was replaced. He had wanted the camera adjusted higher to give a little more range (side coverage was OK), but apparently it's in a fixed position.	N/A	
4681	77	M	BAS alarm should be louder, as he's hearing impaired.	No problem. Very helpful in that it keeps him from hitting his garage	No change in driving habits.	Mercedes (other vehicle) doesn't have such a feature – says they are behind the times in this	

ID #	Age	Gender	Backing aid system (BAS) improvements needed?	Is the technology helpful or hurtful?	Changes in driving habits?	Vehicle manufacturers doing enough for needs of older people?	Other concerns?
				door.		technology.	
4929	74	M	Chrysler 300C – will check at the dealership to see if they can turn the volume up. His hearing is not as sensitive as his wife's. Chrysler also has lights which help, see them in the rear-view mirror.	Helpful – when you start to back up, people or other vehicles in a parking lot will walk in back of you or drive behind you when you are already moving.	Had a Cadillac Escalade (louder alarm) before. Chrysler is actually wife's car. BAS has four "lenses." Cadillac Escalade also had four, but it had wider peripheral coverage than the 300C.	N/A	Other comment – you can get back up bulb replacements for your vehicle that have a beeper/audible warning system built into them – a simple bulb replacement is all you need. He thinks they are around $15.00.
2423	86	M	Lincoln Aviator – Volume should be louder and the tone frequency of the warning system should increase as you get closer, not just sound more rapidly.	Very helpful – says he's in an unusual situation with tight traffic near his work. Work location is right on the corner of a roundabout, and the system helps him get out of the way quickly while backing, as people are changing lanes in that area, and will not slow down.	Yes – it took him about two months of on/off driving to get used to the system.	Horn (alarm) seems to get softer as the car ages. (Wife says that it his hearing that is deteriorating, not the vehicle).	

ID #	Age	Gender	Backing aid system (BAS) improvements needed?	Is the technology helpful or hurtful?	Changes in driving habits?	Vehicle manufacturers doing enough for needs of older people?	Other concerns?
3083	74	M	Lincoln Town Car had four sensors. Distance detection was OK, but it would help if it would detect small poles in the center of the rear coverage area. It had very little side coverage. The Buick he currently has only has two sensors, and even less side coverage.	It is very helpful in detecting kids in a parking lot when they run behind him while he is backing up. He can't see them in the mirrors, but the device detects their presence.	Yes – it made him more careful when backing up. It took him a few weeks to adapt to the device.	On the Lincoln Town Car Signature Series (survey vehicle), when you open the door, the seat slides backwards to assist you in getting into the vehicle. When you put the key into the ignition, the seat goes back to your predetermined position. The Buick he has now does not have that feature. It would be good if all vehicles had that feature.	

APPENDIX F: COMMENTS FROM TELEPHONE INTERVIEWEES WHO OWN REAR-VIEW CAMERAS

ID #	Age	Gender	Rear-view video (RVV) camera improvements needed?	Is the technology helpful or hurtful?	Changes in driving habits?	Vehicle manufacturers doing enough for needs of older people?	Other concerns?
2775	63	M	Need to provide more light for camera when backing up in case someone is in the shadows. Camera has limited angle of view.	No problems. Member always looks over shoulder and checks mirrors because of narrow rear-view angle. He thinks a back up beeper would help.	No change of driving habits, still looks over shoulder and checks mirrors	Not enough, MFGs need to combine RVV with back up sensors and beeper. Also vehicles need a lane change warning device in case someone darts into the opening you intend to change lanes into.	none
3471	36	F	Would like a "lower view," "left view," and "right view" like a picture in picture on the screen	"I almost backed into someone I did not see in the RV mirrors who stepped behind my car as I shifted my attention to the rear view camera. The camera had not picked him up yet as I started backing".	I do not look back the entire time I back up when I use the RVV. I can then look at the screen and front of my car to back out safely. I took about two months to become accustomed to the RVV camera.	no response	none

ID #	Age	Gender	Rear-view video (RVV) camera improvements needed?	Is the technology helpful or hurtful?	Changes in driving habits?	Vehicle manufacturers doing enough for needs of older people?	Other concerns?
3423	63	M	I back out of a long driveway and onto the street, and depending on the angle of the sun the screen is washed out and you can't really see what's coming on the screen. The camera needs to show more of what's on the left and right. The screen needs more contrast and a sun shade to prevent washout. They need better depth of view or depth perception to the screen, perhaps two cameras to provide depth of vision.	I use the backup camera as an adjunct and don't rely on it exclusively. I use my rear view mirrors also. However I lost sight of my other car parked along side me and rubbed up against it when backing up. I feel if the camera showed more of what's to the left and right of my vehicle I would have seen it in time.	I haven't changed my driving habits since I use my mirrors and look as my first source of information and use the rear view camera as an adjunct.	Not enough. Get people off cell phones with completely hands-free systems where you just talk to the car, no headsets or things plugged into your ear and hands-free dialing. Also blind spots are a problem, need better mirrors. He then described his ideas for an improved rear view mirror that features curved or bent ends to show vehicles in what would normally be blind spots.	none
4162	53	M	I would like to have more light to the rear of the SUV when backing up at night	I haven't had any problems. It's good for backing up my SUV.	I have come to depend on the camera more when backing up my SUV and don't look over my shoulder as much since you can see much more with the camera. This took just a couple of months. My wife doesn't use it very much but I do.	The manufacturers seem to be doing OK.	none

ID #	Age	Gender	Rear-view video (RVV) camera improvements needed?	Is the technology helpful or hurtful?	Changes in driving habits?	Vehicle manufacturers doing enough for needs of older people?	Other concerns?
4750	85	M	I would like a wider angle to the lens for a better view	"I thing the RVV camera is a very good thing for backing up". His wife stated, "I couldn't live without it."	I look both left and right and then use the RVV camera; I've come to rely on it. I use it all the time.	He thought they were doing OK and stated the SUV is great for an aging population because of ease of access and seeing out of.	none
932	62	F	I would like to see a beeper that comes on when backing up like the work trucks you see.	I have had problems when backing up and the sun hits the RVV camera just right and wipes out the image. Otherwise I think the RVV is great in parking lots when backing up.	I haven't really changed my driving habits, I still look back before backing but when my arthritis flairs up I depend on the camera more.	Doing OK. "I think the SUV design with its higher seating and better visibility helps older drivers. Some of the features I like are the power rear hatches and heated seats that really help when my arthritis flairs up."	none
3329	48	F	I would like a distance indicator to the object behind me, also I would like to be able to move the camera left and right to see better. Sometimes shadows are a real problem in seeing what's there. I would like better clarity in the picture.	I think it’s a positive thing especially for parking. I really love it when parking. I wouldn't buy or rent a car without it. I haven't had any problems.	The RVV camera has really helped me with parking. In the past I would look for the really open spaces. I'm more confident now when parking and will park in smaller spaces.	The manufacturers could do more to make it easy for seniors to get into and out of vehicles. They are not as strong as they used to be and seats need to be easily adjusted.	none

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1511	55	M	The RVV cameras should have much better resolution and a sharper image. The image is distorted at the edges, it suffers "fish eye distortion."	I haven't had any problems with the system. I and my wife have a hard time judging distance with the system.	I haven't changed my driving habits, not at all; I still look back before backing and use my mirrors.	The manufacturers could do much more. I feel the rear-view mirrors are really too small, especially the side mirrors. Also like turn signals in the side mirrors. Need a turn signal buzzer for drivers that leave them on for miles.	none
1021	70	M	I would like to have greater contrast and a distance readout on the RVV screen. Mine is slow to come up when it's been cold outside. Also my screen can be washed out by the sun at certain angles.	No problems with the system. It's very helpful with angle parking when you can catch sight of approaching things; however, you can't see 180 degrees behind you.	I haven't changed my driving habits, however I feel safer with the system. It has helped me see kids behind my car in parking lots when the parents were not paying attention to them.	"I feel the manufacturers could do much more than they are." He mentioned stability control as being helpful, along with Mercedes' new system that will start braking before the driver can react to prevent a possible collision.	none
3658	50	M	I would like to see more of a "3-D" type of image to make judging objects (distance) easier.	I find it helpful in parallel parking, that's what I use it for. It gives me a feeling of security knowing it's there and I can see backing up.	It hasn't changed my driving habits, I don't use it exclusively.	I feel the manufacturers are doing plenty.	none

ID #	Age	Gender	Rear-view video (RVV) camera improvements needed?	Is the technology helpful or hurtful?	Changes in driving habits?	Vehicle manufacturers doing enough for needs of older people?	Other concerns?
3741	67	M	I would like to see a better back up lighting system for the vehicle but you might get complaints. I really like the RVV camera system.	I haven't had any problems. It really helps when parallel parking in tight spaces like at the beach. I also use it when backing, especially if kids are around.	I haven't changed my driving habits, but it really helps with parking.	I don't really know what more could be done, perhaps lumbar support for the passenger side. Discussed higher seating as helpful.	none
3376	55	F	To improve the RVV camera I would like the camera to rotate left and right for a better idea of what's behind me and I would like greater depth perception in the image. I would also like a distance gauge.	No problems however I did come much closer to a pole than I thought from looking at the screen but didn't hit it. In parking lots it has helped me see people that had just stepped behind my car that I missed in the mirrors as I started to back up.	I haven't changed driving habits' since I still use my mirrors and look around all the time. It didn't take me long to get used to the system but I use it as an aid and primarily use my mirrors and look over my shoulder when backing.	The MFGs need to work a little harder. I would like a sun visor like on TV that you can pull down and block some of the light when driving into the sun. I would like the mirrors to be much larger and the right hand RV mirror easier to judge distance in. Also I feel my car is way too complicated; it has features I will never learn to use. Simplify the car.	none

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1594	49	M	I would like to have a switch I could flip and have the RVV camera system on when I am driving forward. I think it's much more valuable than my GPS navigation system.	I think it's a fantastic feature. It makes me feel very confident when I'm backing up or parallel parking that I'm not going to hit the vehicle behind me. I have periodic neck problems that make it painful to fully turn my neck and this is very helpful.	It took me about thirty days to become comfortable with the RVV system. It has changed my habits in that I'm very comfortable backing up and parking.	Hmmm, I don't have anything to say about that. I think that the RVV camera system should be required on every vehicle especially those driven by elderly drivers who normally cannot turn their necks very much.	none
5001	50	F	I would like to see a wider field of view in the RVV camera.	Backing out of my driveway to take the kids to school, I can see others walking behind my vehicle with the RVV camera. However, I see them in the mirrors and by looking over my shoulder before I can see them in the camera. It's very useful when backing into a parking spot, etc.	My driving habits haven't changed much since I still look in the mirrors and over my shoulder when backing. I don't rely on the RVV camera only.	I would like to see vehicles that are easier to see out of when backing up. Better peripheral vision. SUVs that are as easy to back up as regular cars.	none

ID #	Age	Gender	Rear-view video (RVV) camera improvements needed?	Is the technology helpful or hurtful?	Changes in driving habits?	Vehicle manufacturers doing enough for needs of older people?	Other concerns?
3792	41	F	I would like my vehicle to have backup sensors that "beep" when near something in addition to the RVV camera. I liked the sensors in my Navigator when backing up to judge distance.	I use the RVV camera to back into my garage all the time, although I would like sensors that "beep" also.	I began to rely on the RVV camera when backing up. This took only one or two months.	The member appeared rushed for time and replied "yes" without any additional input.	none
2215	39	M	The camera points down and I get no sense of distance with it. I would like a distance scale and a greater sense of distance to the left and right than I do now. Frankly, I liked the back up sensors in my Volvo much better. It warned if I was going to hit something.	I find the mirrors and looking over my shoulder more helpful than the camera. It isn't very helpful at night; night vision is not great. The Volvo's sensors worked much better than the camera.	I have become more unfocused with the RVV camera than before. I have banged into more things with this car than another car I have owned.	The member stated he's Generation X and can't speak to the question; he was rushed for time.	none
1521	52	M	I would like a better wide-angle lens.	I don't want to admit it, but I bumped into something when I first got the vehicle, I got confused with the camera and all the beeping. I went from a small car with nothing to this. It's fine now.	I trust the RVV camera now. It took me about a month to get used to it.	"I'm not old enough to answer, let’s leave it at that." Member seemed rushed for time	none

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523	70	F	The bright sun washes out the screen so you can't always count on it when backing up, that has to be improved along with better distance indication. I would rather have back up sensors that beep when you are close to something.	It hasn't caused any special problems. You can see behind your car but you can't judge distance with it. I would like sensors that beep when you are close to something better, especially if they were in the front and back.	It has not changed my driving habits since I don't count on it and I still look in the mirrors and over my shoulder when driving. The member restated her preference for warning sensors' over the RVV camera. She was very articulate.	No I don't think the manufacturers are doing enough for an aging population. Seniors have trouble turning their necks to look over their shoulders when changing lanes. I would like to see something that allows seniors to change lanes without having to turn their necks.	none
3904	66	M	I would like to see reduced glare on the screen; it needs to be at a different angle. It's not dependable as it is now because of the daytime sun issue. It's good at night. Judging distance is a problem and it needs to be better seeing left and right.	I haven't had problems since the RVV camera is a secondary thing and I look in my mirrors and over my shoulder. It's good for seeing something behind my car right down to the bumper. The RVV camera works better at night than in bright sunlight.	I did not really change my driving habits except to do an additional check with the RVV camera. It only took a week or so because of the novelty. You put your car in reverse and the picture is there, provided the sun doesn't wash it out.	I think the car manufacturers are doing enough. What else can they do?	One of my concerns is that if the manufacturers put more cameras in cars, seniors will become dependent on them and will not even attempt to turn their heads to look to the side and back of their cars.

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1627	56	M	I would like to see a camera in the front for parking purposes that shows the front bumper which is hard to see in a SUV. I would like greater picture clarity and also an image that gives the location of the wheels in relation to the curb to aid in parking. I would like better vision at night.	The RVV camera aids greatly in parking, especially parallel parking. It aids in backing up, I saw a second car that was backing up at the same time and avoided problems and saw a friend behind my car I did not catch with the mirrors. I would like sensors to alert me to look at the camera when something is behind me. I've never had a problem. I depend on it quite a bit.	I haven't changed my driving habits, however my parking has improved a lot. I get closer to the curb – nothing otherwise. The distance graphics on my screen seem well thought out and they are accurate. I got used to it right away.	I think they could do a lot more with legibility and lighting of instruments and controls. They could improve seating a great deal and make it a lot easier to get in and out of a car. It can be designed a lot better for the limited mobility of older drivers. I would like to be able to simplify the number and improve the legibility of instruments on the dash with the flip of a switch. A senior doesn't need a confusing number of gauges and controls.	In general, I would like to see the vehicle simplified for the senior driver, "simply on demand."
1519	45	F	It seems pretty sharp. Overall I use it but don't rely on it. I can't think of any improvements	I find it helpful when backing out of a driveway to look behind me. I use it parking since I can see how far I am from the curb.	I have not changed my driving habits since I don't rely on it. I do feel more secure since it's another check.	I think the manufacturers are, but I can't think of any examples. I think more is being done for the convenience of younger people.	none

ID #	Age	Gender	Rear-view video (RVV) camera improvements needed?	Is the technology helpful or hurtful?	Changes in driving habits?	Vehicle manufacturers doing enough for needs of older people?	Other concerns?
4911	67	M	Member's husband responded. The view screen needs a longer shade over it, when the sun is overhead it washes the screen out. I think it's a boon.	No problems. I always use it when getting near another car. It's very useful when parallel parking. Its image is not great at night; better backup lights would help. When I back out of my driveway you can see cars that are coming, especially at night when you can see headlights quite a way off.	I didn't change my driving habits. I still use my mirrors and look over my shoulder when backing. It's an additional piece of information.	I don't see any big problem; I think all vehicles should be equipped with RVV cameras. I think vehicles should be equipped with backup buzzers, especially hybrids like mine; someone stepped directly behind my vehicle once when I was backing up since it's completely silent at that time.	none
474	48	M	Member's husband is the primary driver of the car, so he responded that the system needs better low-light capabilities and a little wider angle lens than the present system has.	The system makes you really dependent on it when you really should be looking over your shoulder and using your mirrors. It gives you a false sense of security. When I first got my car I backed into my trash can using the system at night. It needs better low-light capability. It's great for backing into your garage and parking in tight spots.	I changed my habits at first and the system made me really dependent on it. It gives you a false sense of security. It wasn't until I backed into the path of an oncoming car that I realized that I still have to use my mirrors and look over my shoulders when backing. I got used to it quickly and it took about six months before a	I think they are; convenience is a big factor. Where the manufacturers are falling down on the job is making affordable fuel-efficient vehicles. Seniors are on fixed incomes and from my parents' example fuel costs become a big issue. The discussion turned to entry level cars for young people that were being bought by middle aged drivers because of affordability.	none

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					couple of close calls changed my use of the camera.		
3106	72	M	The camera seems OK, but it's best at night. It's hard to see the monitor; it's washed out by the sun and you are wearing sunglasses which makes it hard to see. The system has a limited field of vision so a wider field of view would help.	I haven't had any problems, but I still do not fully trust it. I still look over my shoulder when backing up. The camera is helpful when parallel parking. My Lexus also has sensors that beep when you get close to something, and I find them more useful than the camera when parking, especially to the front and sides.	I don't think the RVV camera has changed my driving. I guess I'm old fashioned. I still look over my shoulders when backing up.	I've driven Lexus vehicles since 1992 and they have great safety features. I guess it's hard to answer, the manufacturers could do more.	none

ID #	Age	Gender	Rear-view video (RVV) camera improvements needed?	Is the technology helpful or hurtful?	Changes in driving habits?	Vehicle manufacturers doing enough for needs of older people?	Other concerns?
4352	57	M	It's difficult to judge distance with the RVV camera, I would like to see a distance "meter" to see how far you are from something.	I haven't had a problem; the system is useful to help spot kids, just not accurate for judging distance. It helps with parking.	I changed my driving habits; I now look in the screen first then look over my shoulders. I got used to it in a couple of days.	I think the manufacturers are trying to accommodate the female population since they decide what car to buy. Not so much to accommodate the older driver. I think the vehicle shouldn't be too high and the seats should be firmer.	none
3636	44	F	The screen is washed out in the sun, that needs to be better and the backup lights need to be brighter at night for the system to work better.	The RVV camera is good when backing up for seeing pedestrians crossing behind your vehicle and cars driving behind your vehicle.	My driving habits changed. I got to depend more on the camera to see what's going on behind my vehicle. I can see things as close as two feet when backing up.	I don't think the manufacturers are doing enough. They should make a bigger rear-view mirror for older drivers, a "panoramic" mirror so they can see behind and to the sides of their vehicles. Also they should work to eliminate blind spots in their vehicles.	The member made the statement, "If they are too old, they should not drive."

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2005	54	F	I would like to see a larger area covered by the camera than I see now. I think warning "beepers" for parking are more accurate than the camera. When it rains hard the camera gives poor results.	I use it all the time but don't rely on it completely. I still turn my head and look. I've seen kids, bikes, etc. behind my vehicle. I've noticed that things are actually closer behind my vehicle then they appear in the RVV screen, which could be a problem.	I haven't changed my driving habits. I still turn my head and look. I'm a school bus driver and have learned that a lot of things can be behind your vehicle!	I really think we go too far sometimes. We really should have the skills to drive or we shouldn't be on the road.	none
1554	41	M	I think the camera is great however mine over estimates distance, when I check I have four or five inches more room to back up. At night the image is very grainy; they need better light when backing up.	I find the RVV camera very helpful, I used to drive nose first into parking spaces, now I back into parking spaces almost 100 percent of the time. I haven't had any problems caused by the camera.	It changed my parking habits as noted. It took me about a month to become used to the camera and about two months to become completely used to it.	The MFGs could do more. I think any visual aids would help them. Seniors tend to get shorter, so seats that can compensate would help. An option I saw on the "Infiniti M" that warns you when someone is beside you when you change lanes is useful. Blue tooth technology is helpful so you can talk hands-free on the cell phone.	The member asked who was conducting the survey, so I answered his question.

ID #	Age	Gender	Rear-view video (RVV) camera improvements needed?	Is the technology helpful or hurtful?	Changes in driving habits?	Vehicle manufacturers doing enough for needs of older people?	Other concerns?
3813	64	F	I would like to see a wider field of view in the RVV camera. The sun washes the screen out on a bright day. Otherwise it's great at night or on an overcast day.	The RVV camera really helps in a shopping center parking lot to see people behind you. It helps with parallel parking and backing up. I haven't had any problems caused by the camera.	It didn't take us too long to get used to the camera. We forgot to use it at first. You still have to look around in case someone is behind you and out of the camera's field of view.	I think they need more backup cameras. Especially for minivans, they could really use it. Otherwise I can't think of anything.	none
3335	45	F	I would like a wider scope of vision and better ability to judge distance with the camera. Warning sensors would also help when backing up.	I haven't had any problems. The RVV camera is very helpful when backing up to judge the distance to the curb when parallel parking, seeing the red line on the curb when parking, and seeing what's behind you.	I have changed my driving habits. It took me a couple of weeks to get used to the RVV camera, and I'm still figuring out things I can use it for. I've stopped turning around to look now that I have the camera. I haven't done that for better or worse for some time now.	Probably not. I think the vehicle gauges, etc., need greater legibility. Seat belts need to be easier to use. At a certain point a senior's faculties start to go and if the MFGs do too much I am afraid they will be driving beyond the point they should be on the road.	none
599	36	F	The member's wife answered since he wasn't home. The sun glare can wash out the screen during the day and the image is grainy at night. I would like a better image.	I use it all the time for backing up to look out for kids and animals. It's great for parallel parking.	I have changed my driving habits. I've become dependent on it. I don't look over my shoulder as much anymore. It took me about six months to really trust it.	It's hard to say. In my experience, seniors now drive older big American cars. I can't think of anything except they should build more Hybrid cars because of the operating expense.	none

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82	75	M	I would like the camera to cover a larger area. Also a sensor that beeps when you come close to something would be helpful. I would like a range or distance gauge on it.	I use it all the time in parking lots to look for people behind the vehicle. I also look in the mirrors. Using the RVV camera has never created a problem for me.	I have changed my habits. I never back the car up without looking at the screen; then I look at the mirrors since my SUV has many blind spots. I got used to it right away.	I don't think so. They should add speed control, bigger mirrors, and higher seats. Better visibility and more glass to limit blind spots.	none
4442	47	M	The member's husband answered since she was out. Both of them think the RVV camera is a great thing. He couldn't think of any improvements that are needed except judging distance.	Both of them think it's very helpful backing up. The wife uses it all the time and he stated that he has been slow to adopt the system since he is so used to looking over his shoulder when backing. He has not had any problems caused by using it.	The wife has changed her habits and uses it all the time and as noted the husband has been slow to use the system since he's used to actually looking when backing. She didn't take much time to get used to it.	He thought they could do more like the self parking car Lexus has. He thought computer controlled features are needed to reduce stress on the driver. He also mentioned headlights that turn with the car as helpful.	none
2916	43	M	I would like to see wider coverage from the camera. Perhaps use two cameras so you can see more to each side of the vehicle. Also you need to be able to see very low and just behind the bumper, my camera doesn't show that now.	Using the camera hasn't caused problems. I find it very useful for backing up into my garage and in tight parking spaces. I don't have to twist my body and neck to look back.	I have changed my driving habits. I use the camera when backing up in familiar areas like my garage and parking in the complex. If the area is unfamiliar I still twist my body and neck to look back when backing up. It	I don't think the manufacturers are doing enough. For SUVs I would like to be able to adjust the vehicle's height and lower the vehicle for my senior mother to get into and out of the vehicle. She has a hard time doing this.	He asked if the report was going to be distributed to the auto manufacturers.

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					didn't take too long to get used to the camera.		
2431	26	M	I would like to see farther back, perhaps at waist or chest level, right now it's tilted down. I would like a better view when backing up.	Using the camera hasn't caused any problems. I use it all the time for parallel parking and parking in tight spots. I haven't had instances of seeing kids or animals behind me.	I haven't changed my driving habits, except for parking. Using the camera is easy, I got used to it in a day.	I haven't really thought about it. I'm still young. I do see the manufacturers loading the vehicles up with lots of gimmicky things like MP3 players, navigation systems, and power windows, locks, moon roofs, etc. that a lot of seniors did not grow up with and do not want. They look at it as something to break and cause expense later on.	none

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1806	65	F	I would like to see the RVV camera screen shielded more from the sun or have it swivel; the sun washes out the image at the right angle. Also I would like to have a camera in front for parking, that would really help, it's hard to see in front sometimes. Also I would like to see more to the sides of the vehicle.	It's really helpful. I use it every time I back up. I glance at the camera before backing. I haven't had any problems caused by using the camera, I don't rely on it 100 percent. I do feel insecure when the image is wiped out by the sun's glare.	I have changed my driving habits when it comes to parking and backing up. The camera really helps when parallel parking, especially in tight spaces.	I can't think of anything off hand right now. I do think there is too much emphasis on speed. They make cars go too fast without feeling the speed.	none
3836	41	M	I get condensation on the camera at night and see spots on the image. I would like to see a distance scale that is exact so I know where I am distance-wise. Also I would like a better sideways view.	I use it for backing up in parking lots and find it especially useful for parallel parking. I haven't had any problems arise from using the system.	I feel more comfortable parking my large vehicle with the RVV camera and learned to use it almost from the first day. Although I'm still not completely comfortable since I would like to know the exact distance.	I think they are OK now. I believe in the law of supply and demand. If they are willing to pay for features that are senior friendly, the manufacturers will provide them.	none

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3086	46	F	The camera should come on sooner when you are backing up. I would like a better brighter image with a wider-angle view than I have now.	I use it primarily for judging my distance after parallel parking to see how close I am to the other vehicle. I don't use it much and rely on looking over my shoulder. I did back into a low retaining wall the camera did not catch.	I did not change my driving habits because I do not rely on the camera at all.	I don't have a real answer to that. The more features the manufacturers add the more complex the car becomes and harder to learn to operate.	The member said, "I really don't know why I've been asked to do the survey twice." I explained sometimes something new comes to mind and the members will sometimes say something they did not want to put in writing.
1438	46	M	Sun glare washing out the screen is a big issue. I would like to see an increased field of view and more depth of field. I would also like a distance scale so I know how far I am from something.	I use it for backing up in parking lots and find it useful for parallel parking. It's especially useful in angle parking when you are parked alongside a longer, taller vehicle and you back out. The camera will show on-coming vehicles you would not see otherwise. No problems using system.	I use the system for parking and backing primarily. It really helps in parking lots. It took me about a month to become comfortable with the system.	I don't know. The manufacturers are putting more gadgets in the cars that older people do not use and are afraid to use or trust them. The technology must be transparent to the driver. You need technology-oriented older people to use them or they will be afraid of them.	The member commented on the location of control switches being located right next to cup holders as a problem and gave an example. He's a computer and software designer. Lots of insight.

ID #	Age	Gender	Rear-view video (RVV) camera improvements needed?	Is the technology helpful or hurtful?	Changes in driving habits?	Vehicle manufacturers doing enough for needs of older people?	Other concerns?
2815	83	M	I would like to see improved distance perception and a brighter and clearer image like the camera in my wife's new Lexus. It's still hard to judge exactly how far you are to the object. I would like to see a wider view of what's behind my vehicle.	I use it for backing up and parallel parking, especially backing out of my driveway in the morning; you know if anything's back there. Using the RVV camera hasn't caused a problem for me. I still look over my shoulder to be sure.	I have changed my driving in that I'm not turning around to look when backing up slowly, I'm depending more and more on the camera for that. I'm still getting used to the camera but you can't fully depend on it, it's an aid. It needs better clarity and a more accurate display of distance.	Well it's becoming easier and easier to drive all the time with better brakes, steering, improved accessories, and interiors. He discussed the latest technologies, and was impressed with navigation systems and verbal directions from them, He mentioned he was an engineer at JPL for thirty years.	none
4544	39	M	I would like to see a brighter, clearer image than I now get and improve its performance in the bright sun.	I am always careful when backing up. I do not rely on the camera exclusively, but I find it very helpful. I look at the camera first to make sure nothing's directly behind me before I back up using my mirrors and looking over my shoulder. I haven't had any problems using the camera because I also look the traditional way.	I haven't changed my driving habits. It took a couple of weeks to get used to the camera for backing out of my garage and parallel parking to judge the distance to the car behind me. I still use my mirrors and look over my shoulder when backing.	I don't know. I'm not in that mode. I'm 39. I think they are doing better. Perhaps you should ask my mother, she likes SUVs because they sit up higher and she likes that for visibility. Vehicles now have bigger sun visors for sun glare and that helps her now that her cataracts are getting bigger.	none

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1229	75	M	I would like a better way to judge distance, which is hard with the current camera. It does give a wide side view.	It's very useful when parallel parking; when it looks like you are close to the car behind you, you are. Very useful when backing out of my garage. I use it to find the end of my driveway just before the sidewalk. I then stop and look around before backing into the street. The main problem using the camera is that you can't judge distance behind you.	I haven't changed my driving habits. It just gives you another perspective when backing. It's a useful tool and it works better at night than you think it should. I got used to it right away.	I don't know. It's hard to twist your neck and look back, in that way the RVV camera is useful although you need a better way to judge distance. (The member kept his focus on the RVV camera.)	none
4828	48	F	Member's wife answered in his absence. It's hard to judge distance and objects appear much closer in the camera than they really are. This needs improvement.	My husband had just started backing up when he saw his son behind the vehicle. I use it for backing and parallel parking where it's very useful.	I haven't really changed my driving habits as a result of the camera. It didn't take long to get used to using it.	I think they are doing enough. I don't know what else they could really do. (Member was busy.)	none

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4784	58	M	I would like to see wider coverage from the camera. Currently the view can be washed out in the sun and it's difficult to judge distance since the object is closer than it appears. Picture quality could be better.	I use the camera for backing out of my driveway and parking spots in shopping centers. But I still do not trust the system because of its narrow coverage. It's possible for someone to "pop up" in the camera because of its narrow field of view. I still look over my shoulder. I haven't had any problems specifically because I do not fully trust the system and still look over my shoulder.	Lets say I'm 50/50 changed. I still look and don't fully trust the system because of my earlier concerns with narrow field of view and distance judging, etc.	I will give them a mixed yes; they are doing enough. The technologies like collision avoidance radar, RVV cameras, and navigation systems are on the right track, but they need to be doing more. Additional items like rain-sensing wipers and auto-dimming mirrors are good aids for seniors so they do not have to fumble to turn them on.	none

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3300	68	M	I would like more clarity in the image and a more accurate sense of distance when using the camera, especially to the sides of the vehicle. I would like to see a flat screen view, not the fish eye distortion I have now.	The camera is very useful when backing into a parking space or parallel parking. It's good for checking if something is directly behind your vehicle. Problems: you can be fooled by the camera. I almost backed into a car parked on the street when backing out of my driveway. Also I almost hit something when backing in my driveway because of the lack of accurate distance perception to the sides of the vehicle. People can appear to pop up behind you because of the lack of view to the sides; you would normally see them if looked over your shoulder.	I really haven't changed my driving habits because you can't rely on the camera view as it now is. I use it as an aid for backing but still look. It took about five sessions with the camera before I got used to it, but I did have the problems mentioned.	I believe the manufacturers are doing enough to accommodate them. The Lexus RX330 I drive has been very good to me and I drive it all the time.	none

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